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United States Patent [19]

Shimada et al.

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[45] **Date of Patent: Aug. 22, 1995**

[54] **POWER LID CLOSING DEVICE**

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[73] Assignee: **Ohi Seisakusho Co., Ltd.,** Yokohama, Japan

[21] Appl. No.: **87,335**

[22] Filed: **Jul. 8, 1993**

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Jul. 8, 1992 [JP] Japan ..... 4-047773 U
Jul. 8, 1992 [JP] Japan ..... 4-047774 U

[51] **Int. Cl.**[6] **E05B 15/02**
[52] **U.S. Cl.** **292/341.16;** 292/201; 292/216; 292/DIG. 43; 70/241
[58] **Field of Search** 292/341.16, 201, 216, 292/DIG. 43, 341.18; 70/241

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Primary Examiner—Peter M. Cuomo
Assistant Examiner—Suzanne L. Dino
Attorney, Agent, or Firm—Foley & Lardner

[57] **ABSTRACT**

A lock mechanism is mounted on a pivotal trunk lid. A lid drawing mechanism is mounted in a fixed member of a trunk space of a vehicle body. The lid drawing mechanism includes a motor mounting plate which is stationary, a striker base plate which is pivotally connected to the motor mounting plate and an output disc which pivots the striker base plate when rotated. The striker base plate has a striker which is engageable with the lock mechanism. A power unit is mounted to the fixed member and includes an electric motor and a speed reduction gear which are installed in a housing secured to the motor mounting plate. A rotation transmitting device is employed for transmitting rotation of the spur gear to the output disc irrespective of a certain axial displacement therebetween.

18 Claims, 20 Drawing Sheets

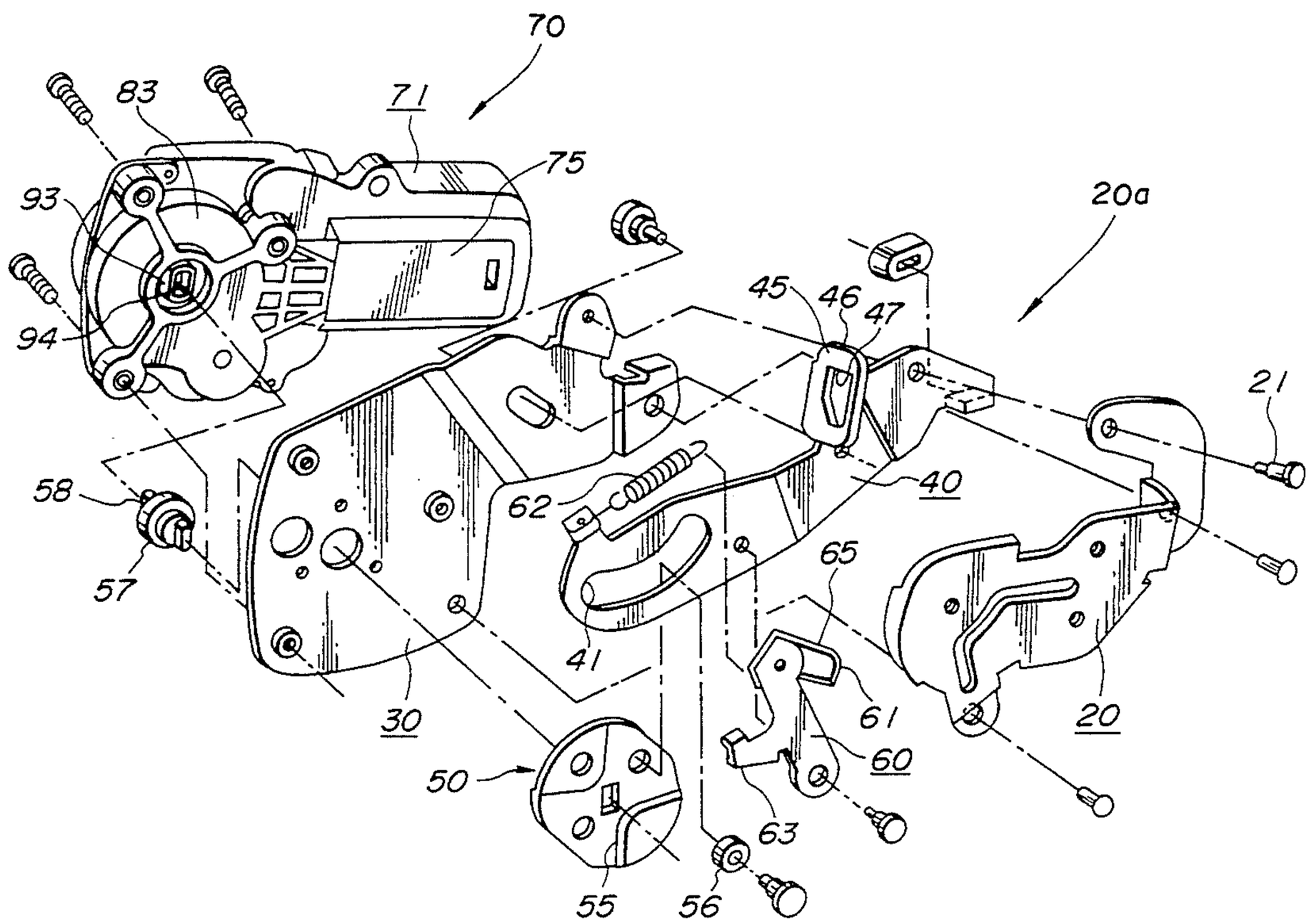

FIG.1

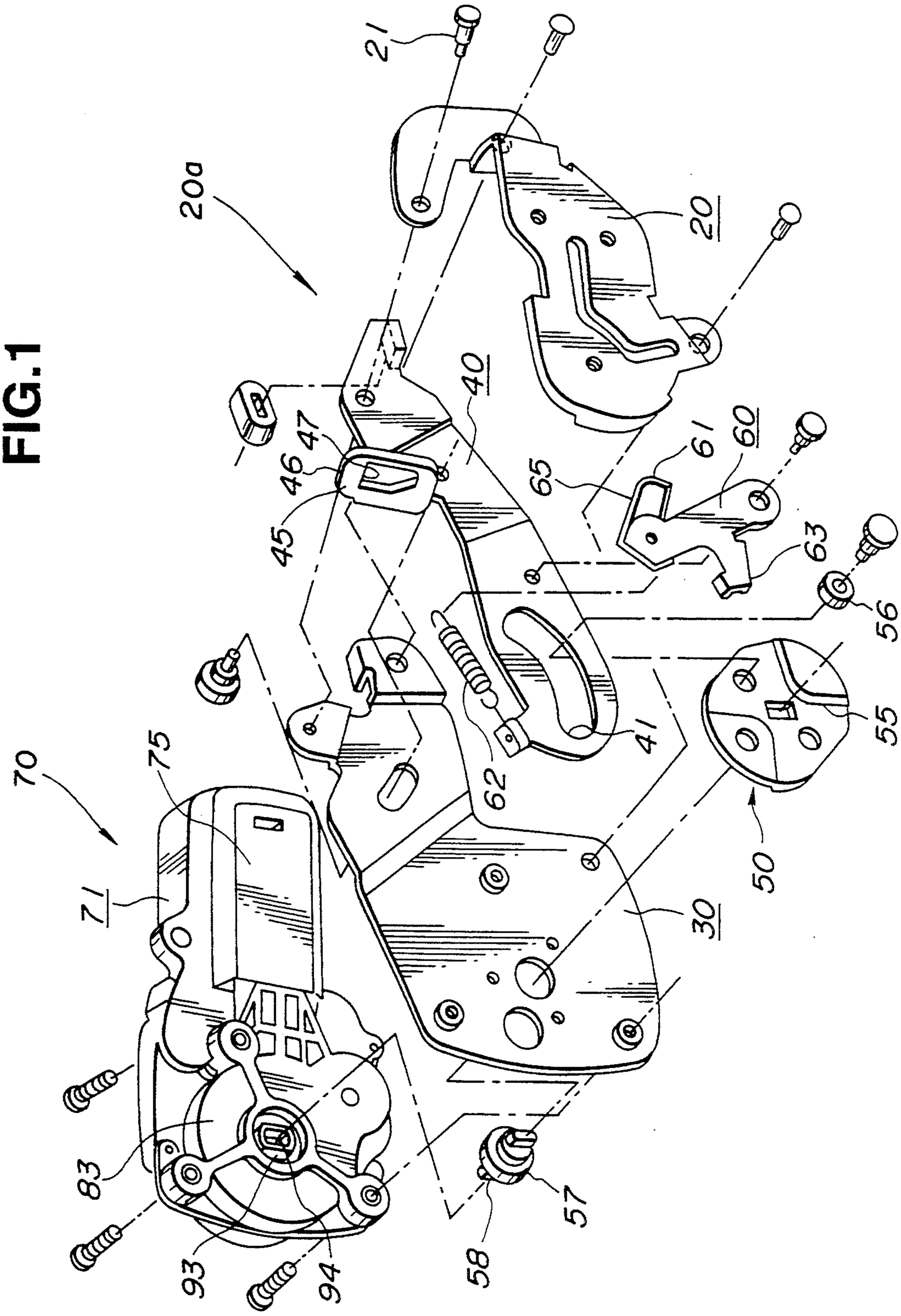
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FIG.2

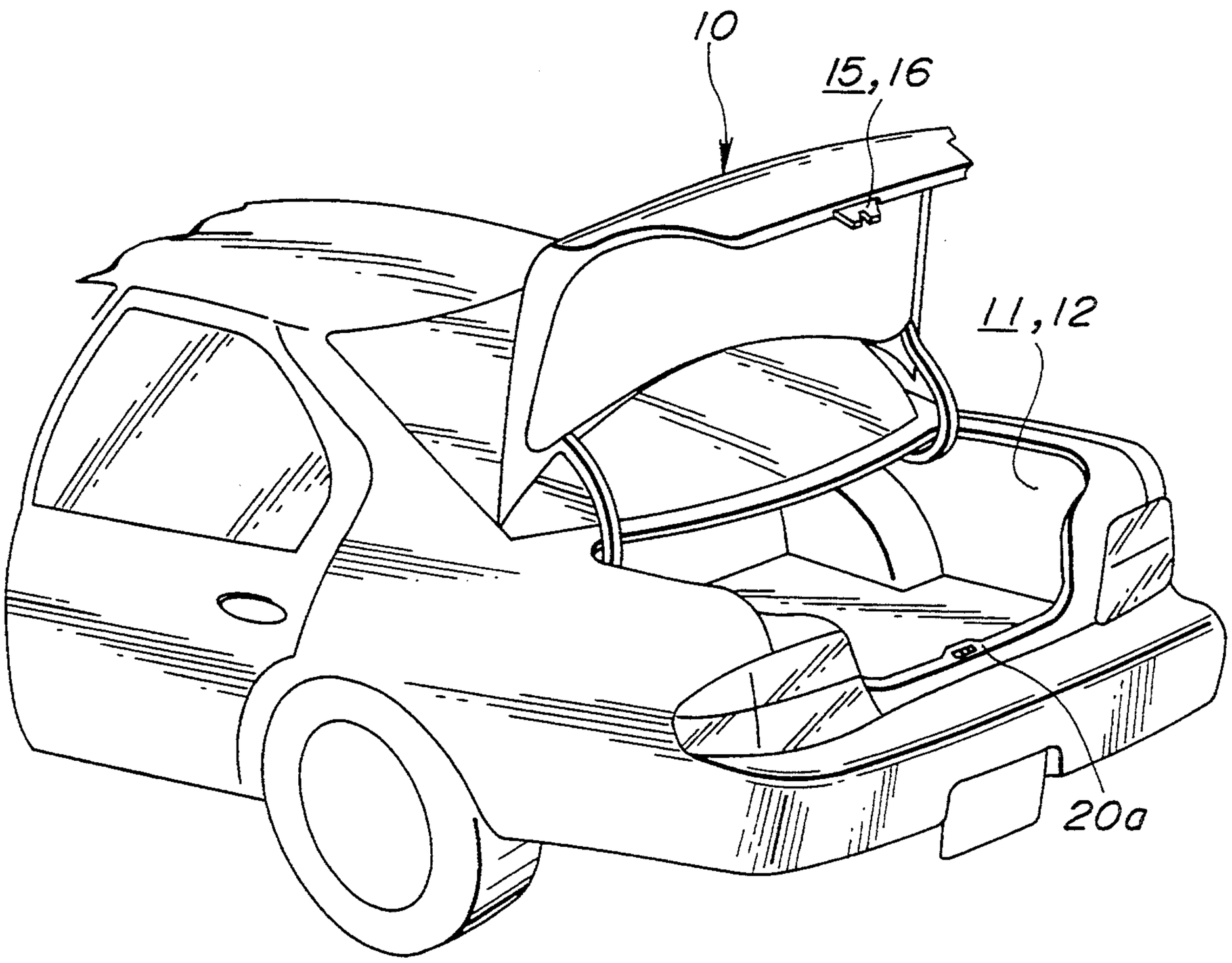


FIG.3

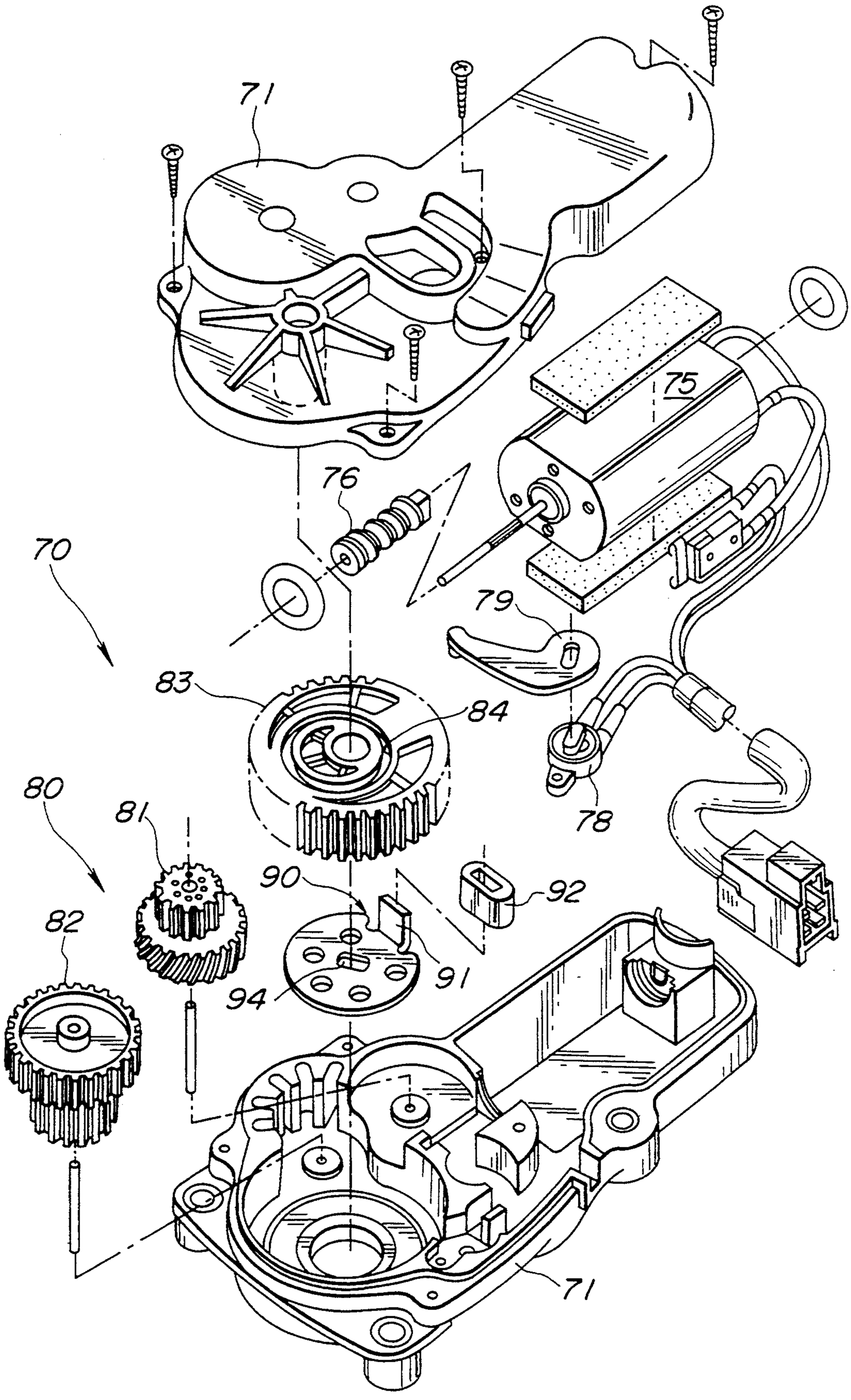


FIG.4

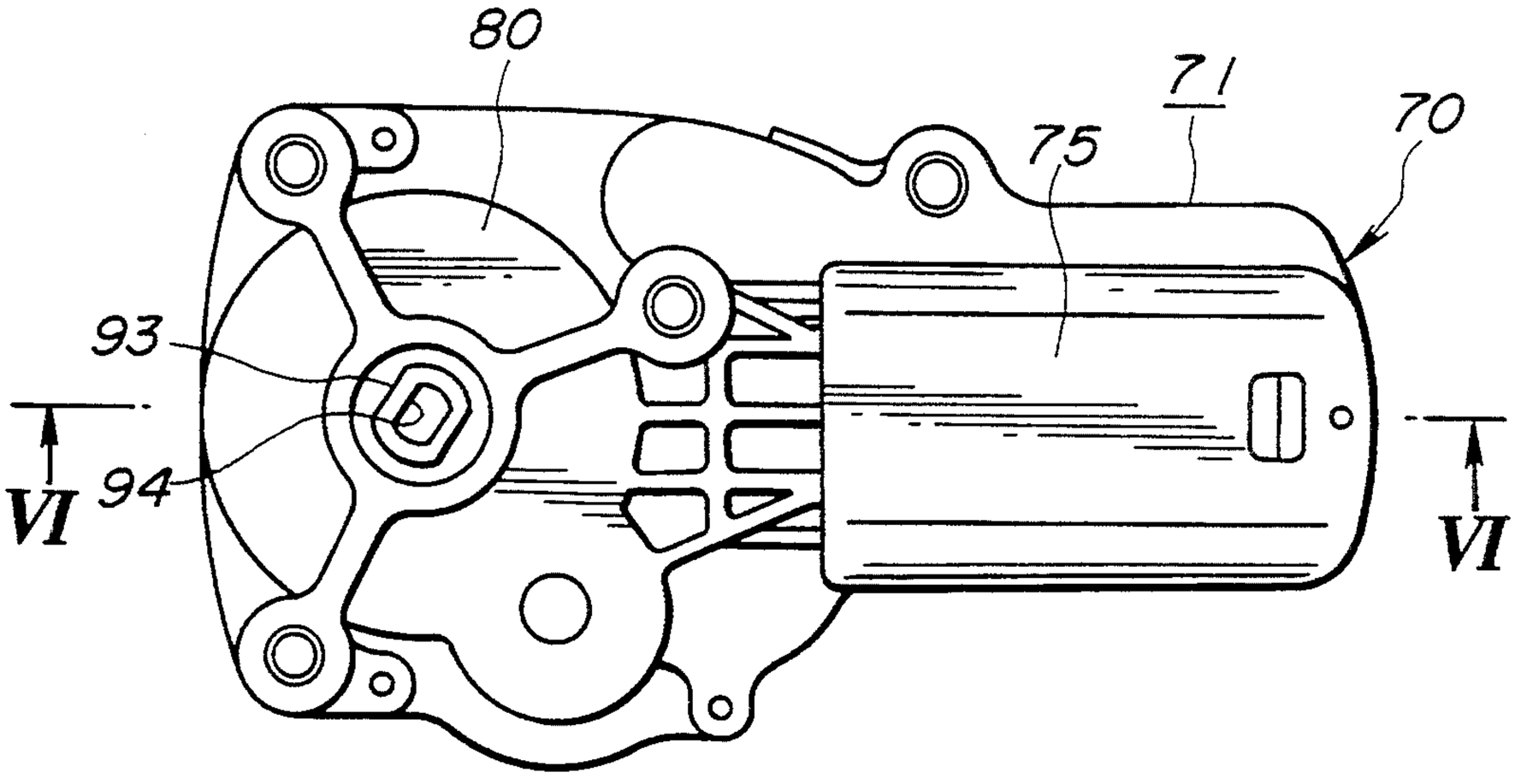


FIG.5

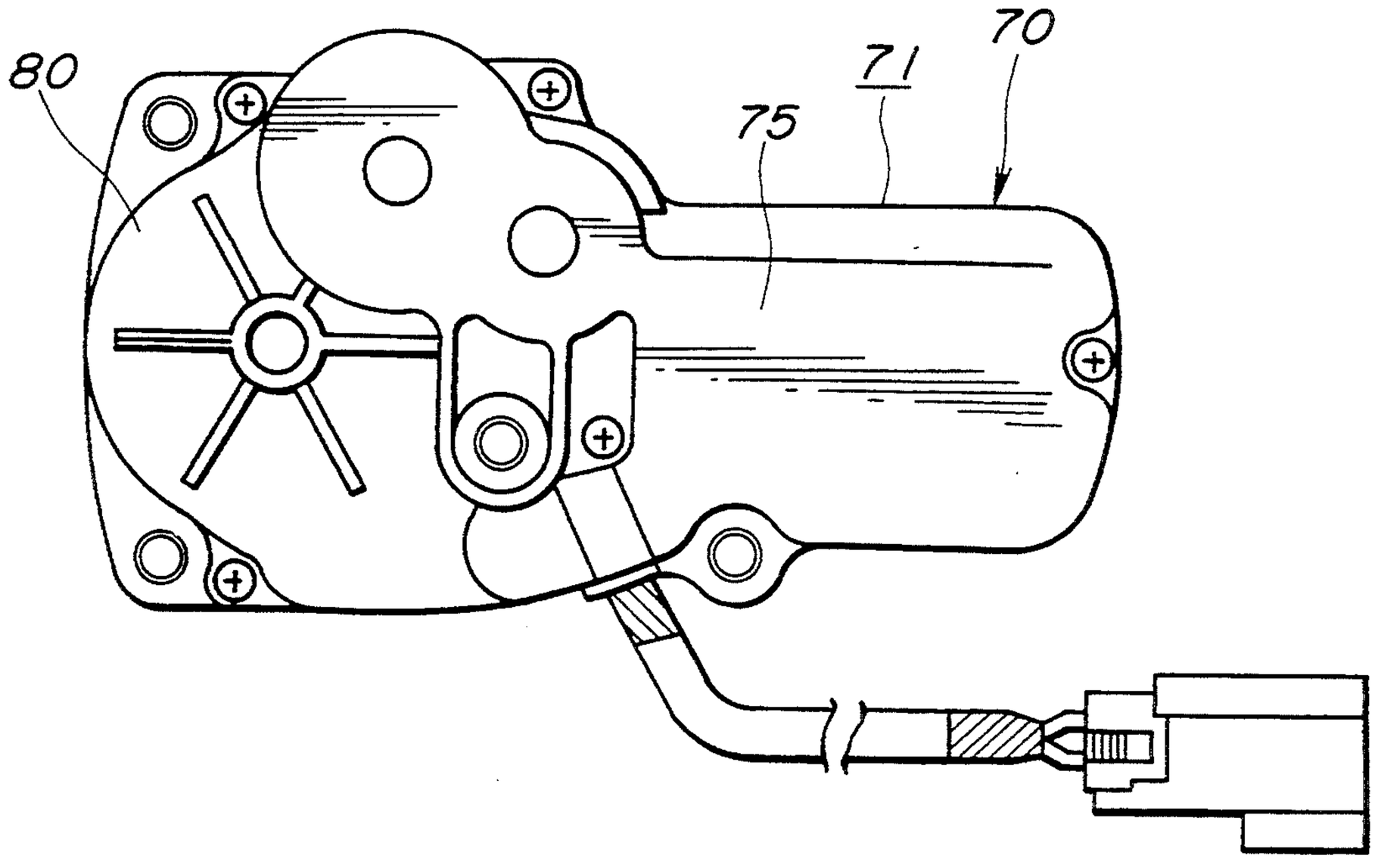


FIG.6

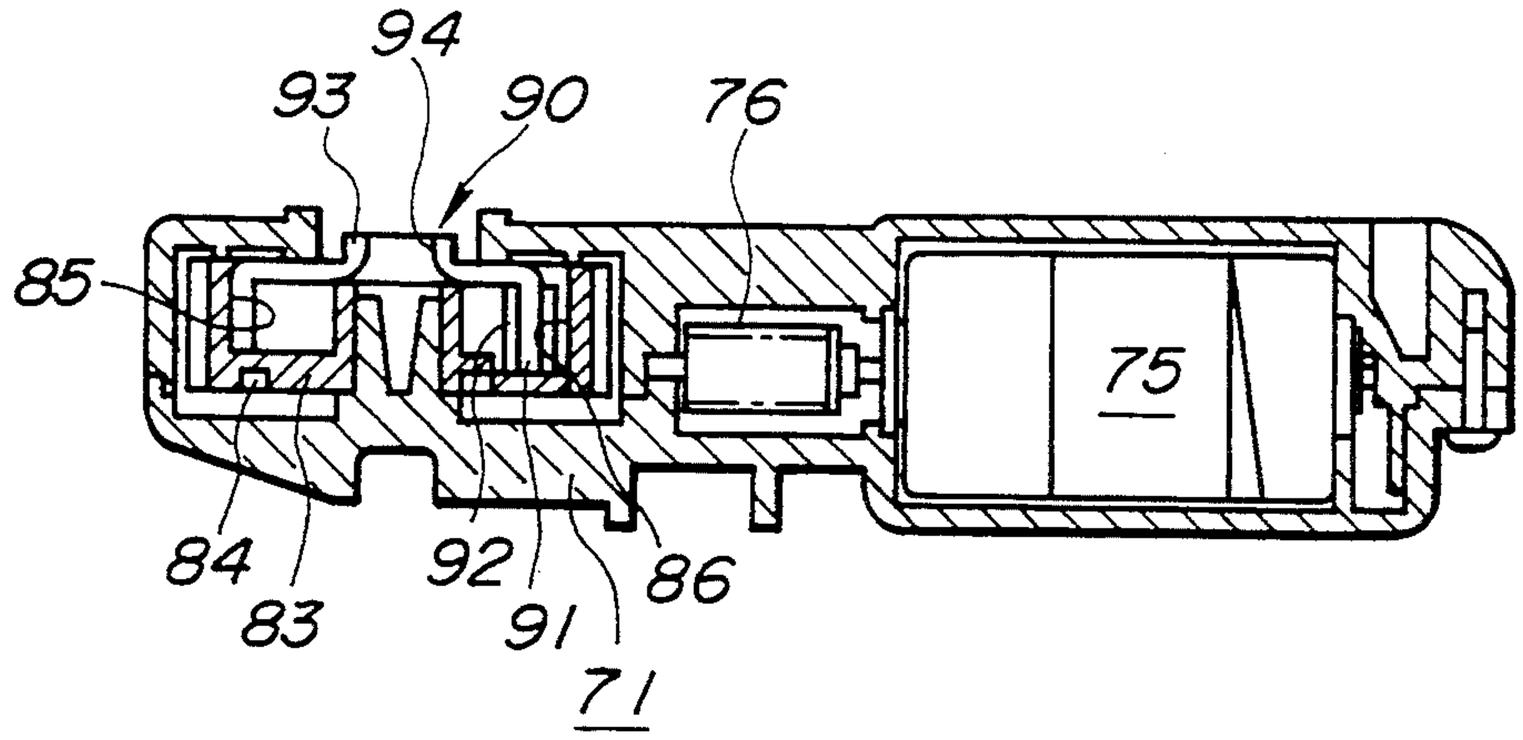


FIG.7

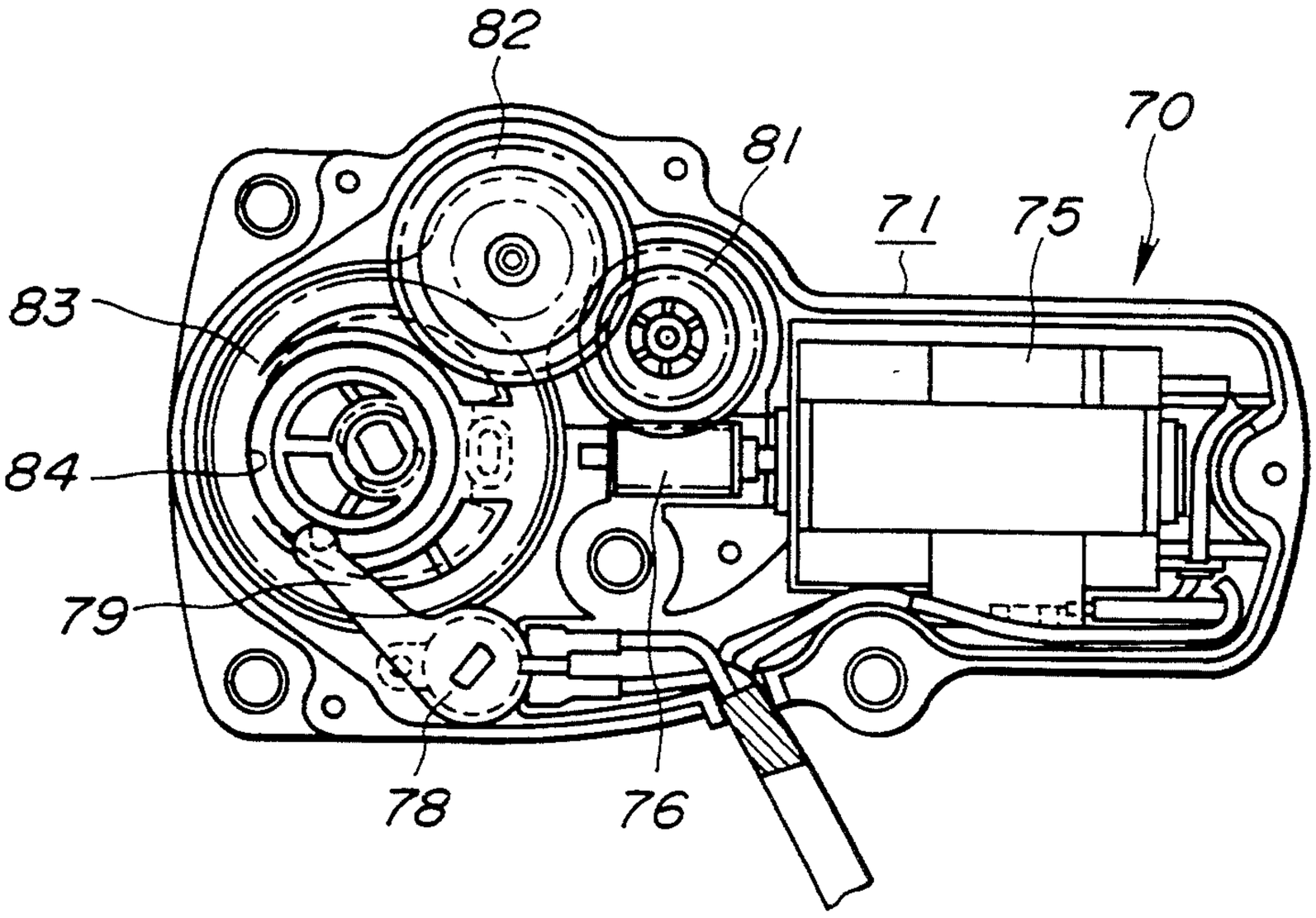


FIG.8

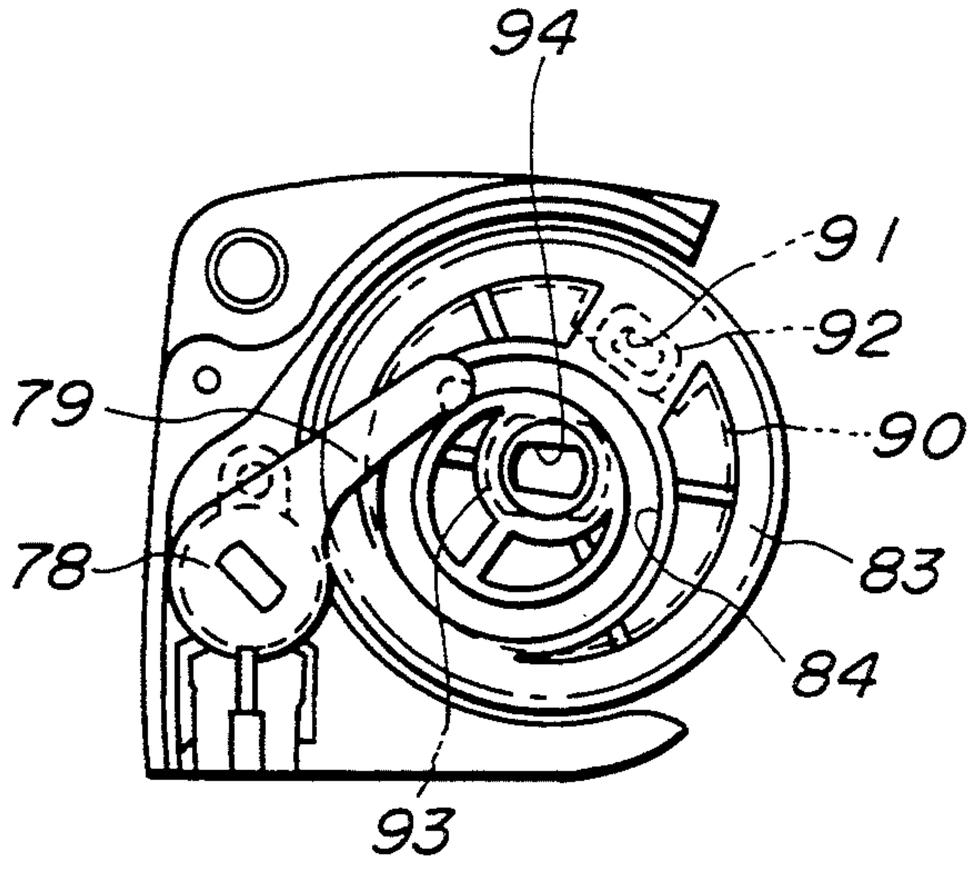


FIG.9

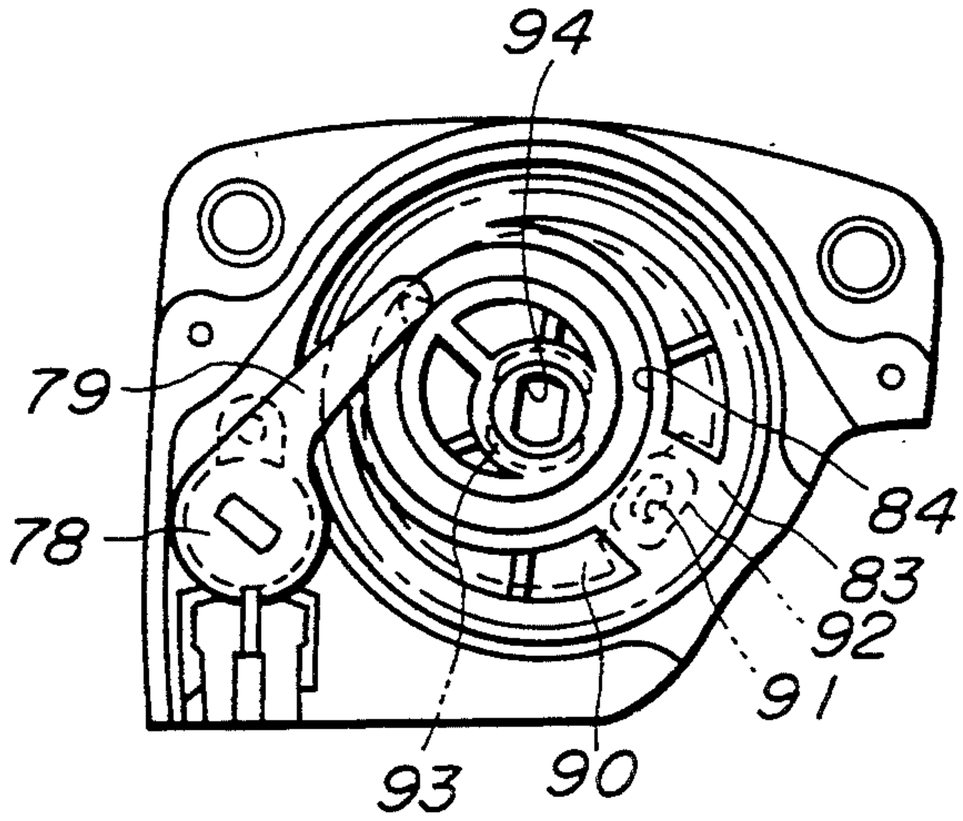


FIG.10

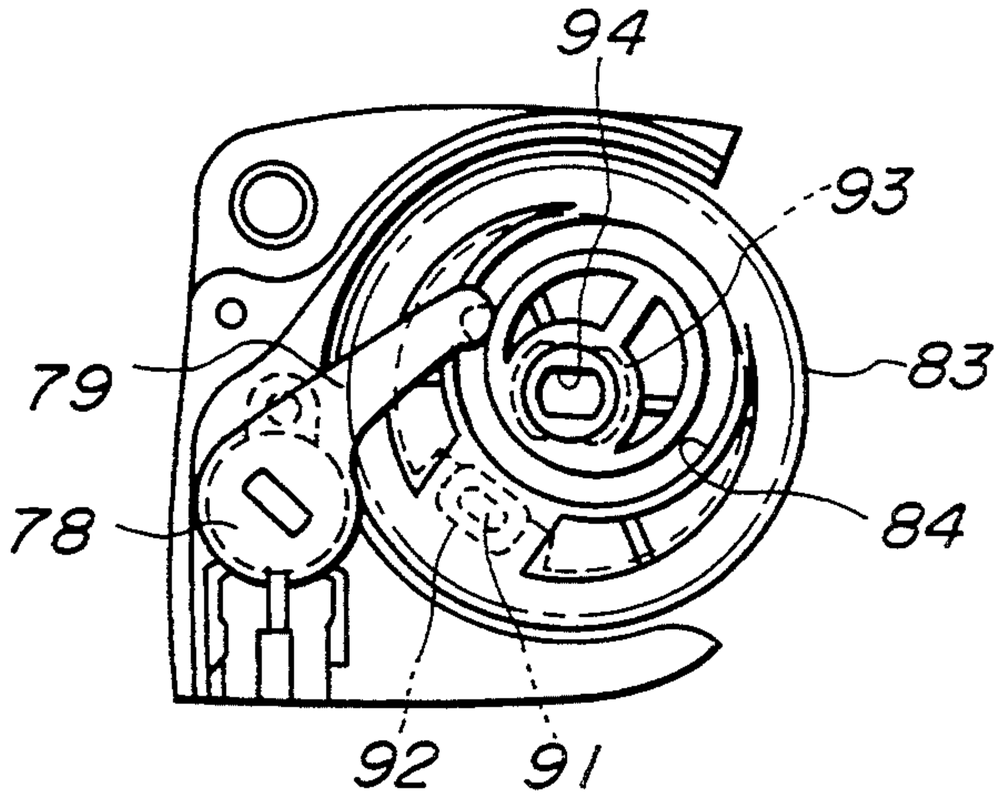
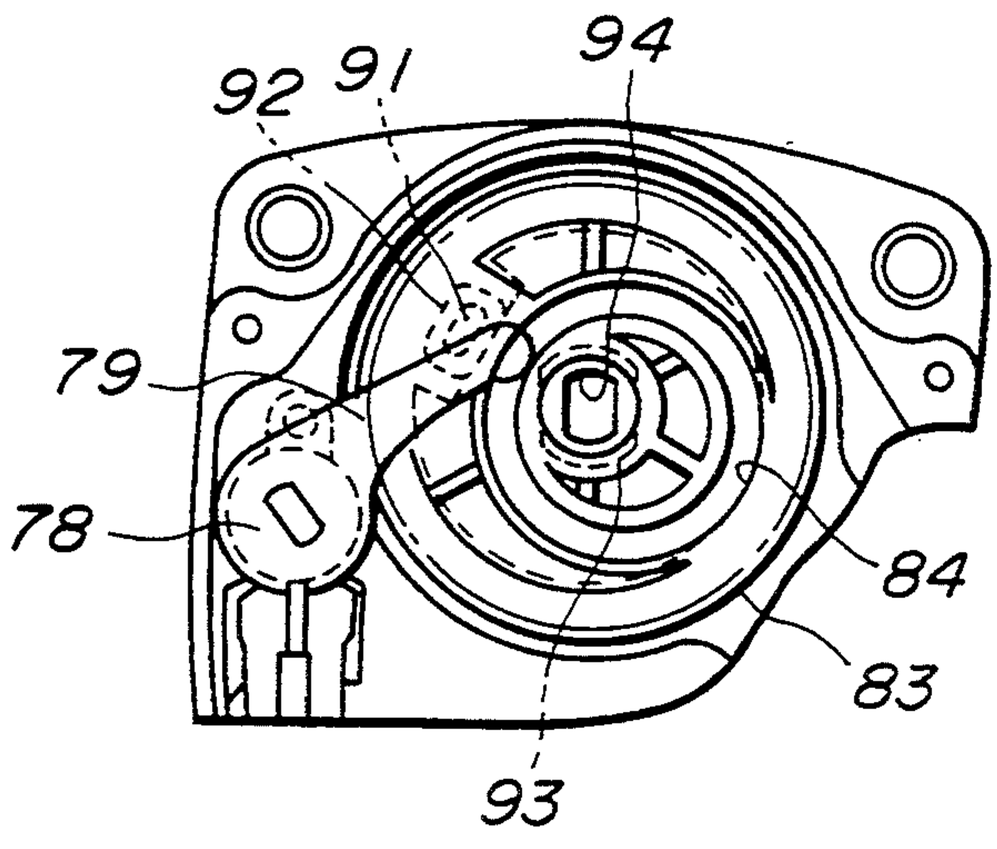


FIG.11



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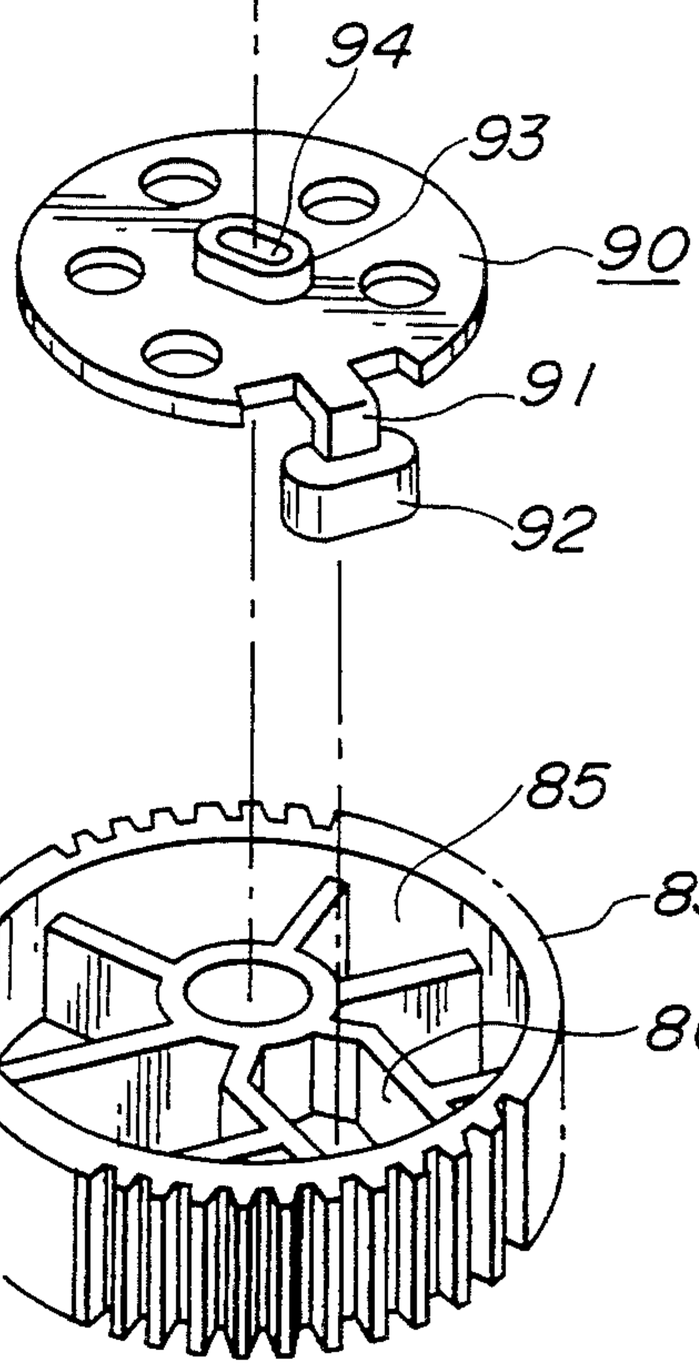


FIG.13

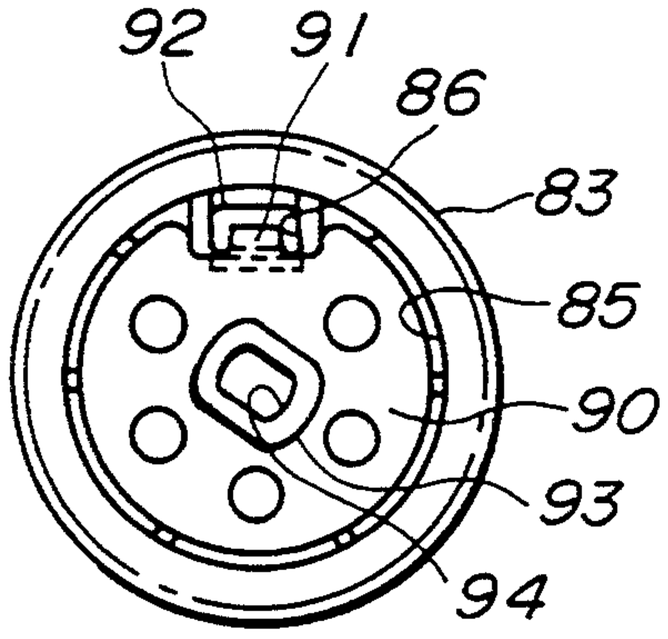


FIG.14

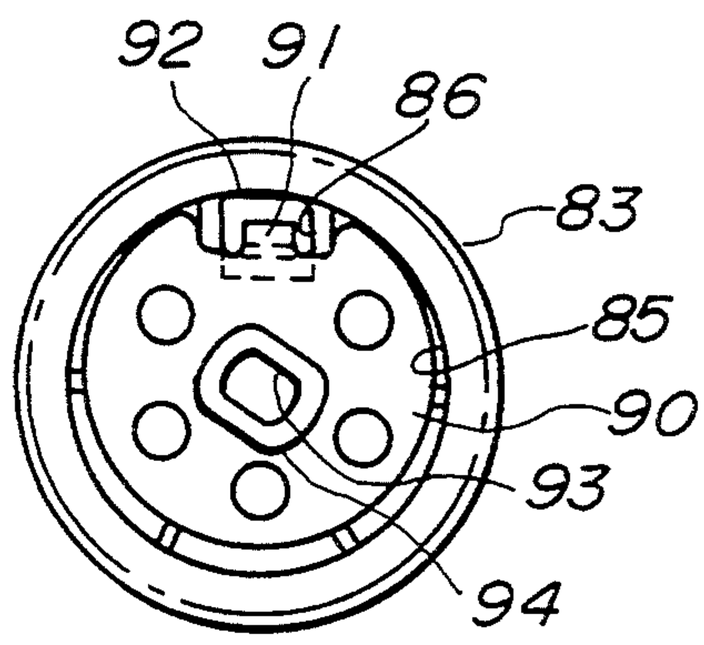


FIG.15

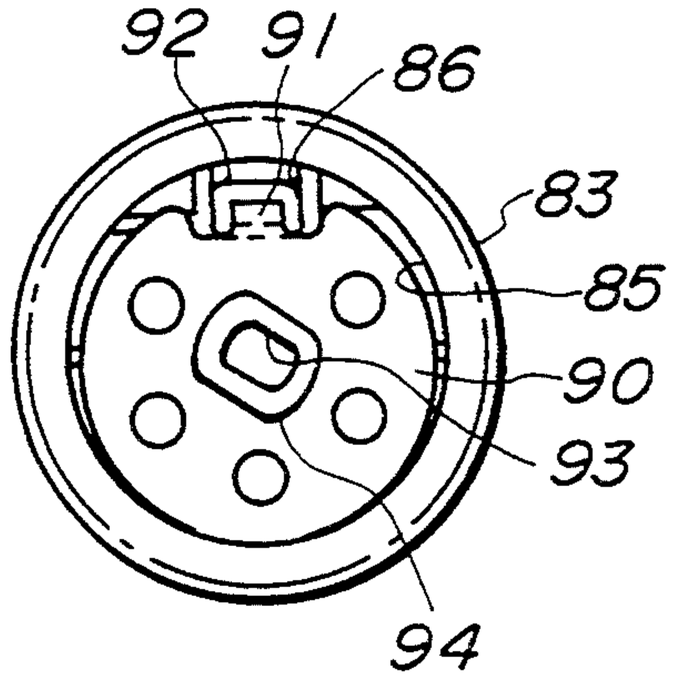


FIG.16

FIG.17

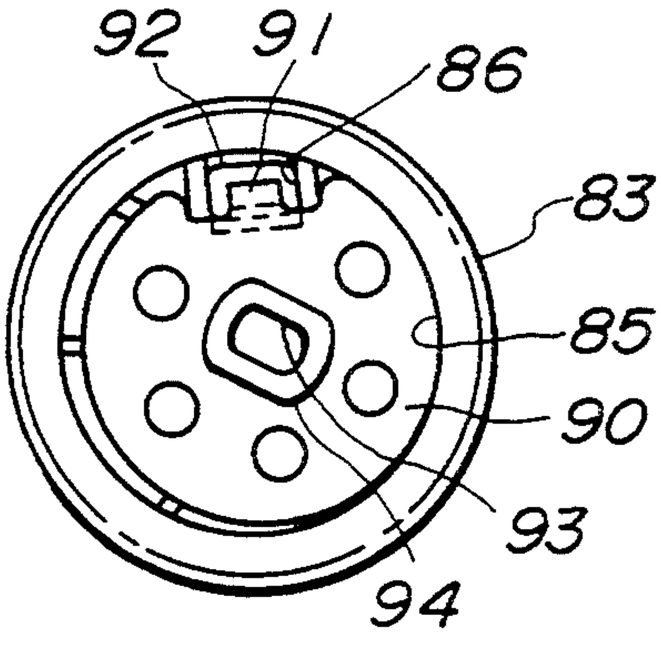


FIG.18

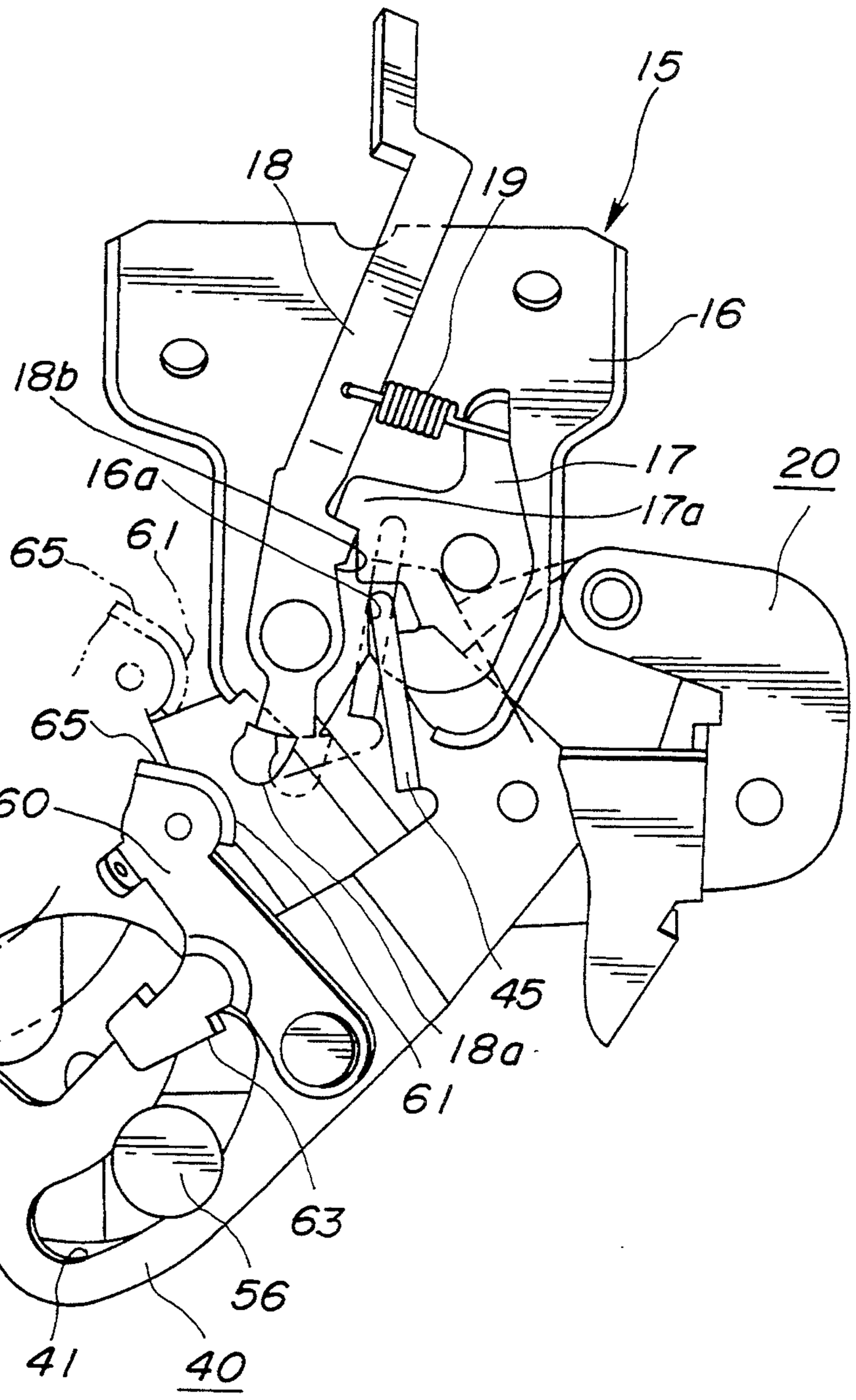


FIG.19

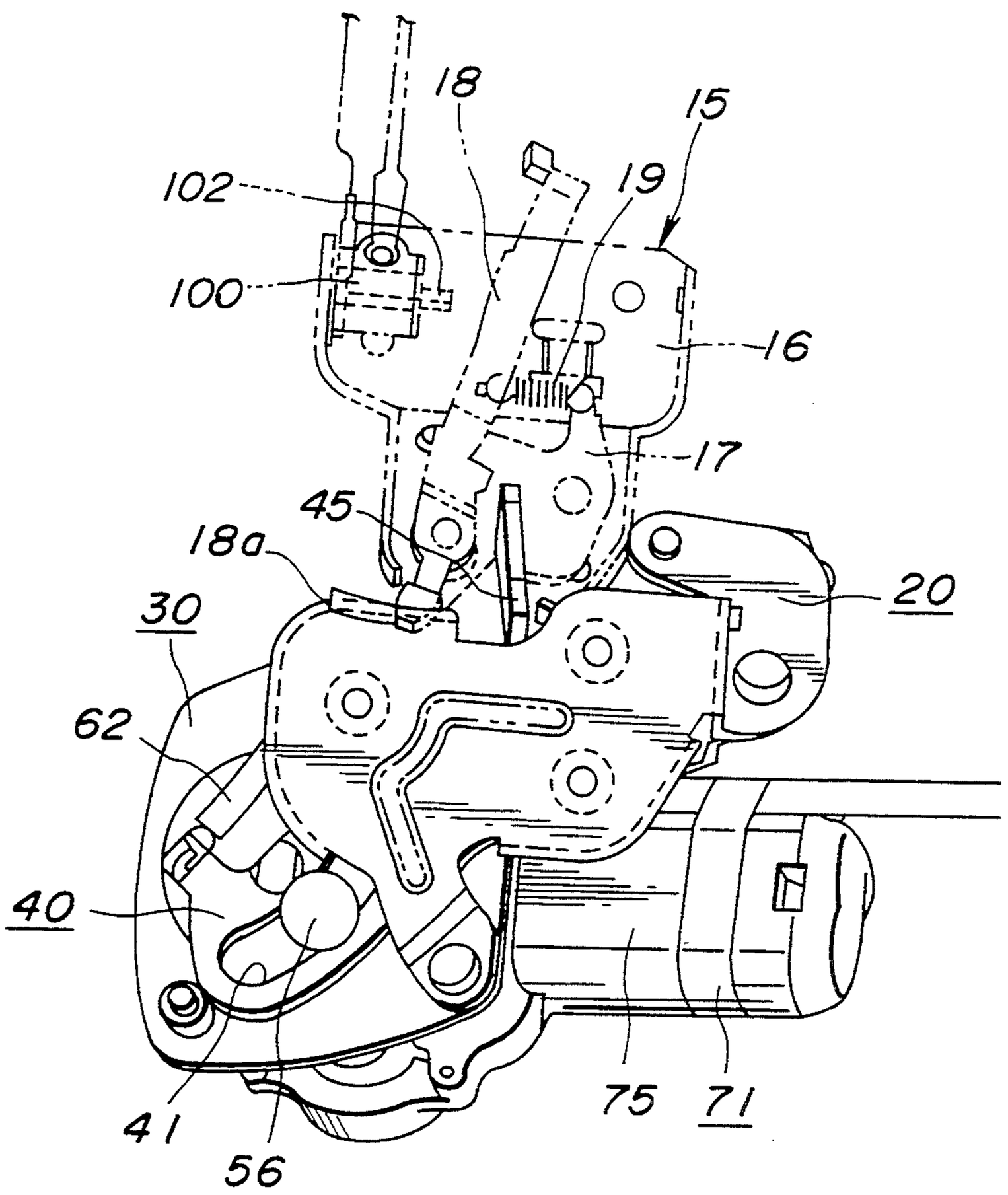


FIG.20

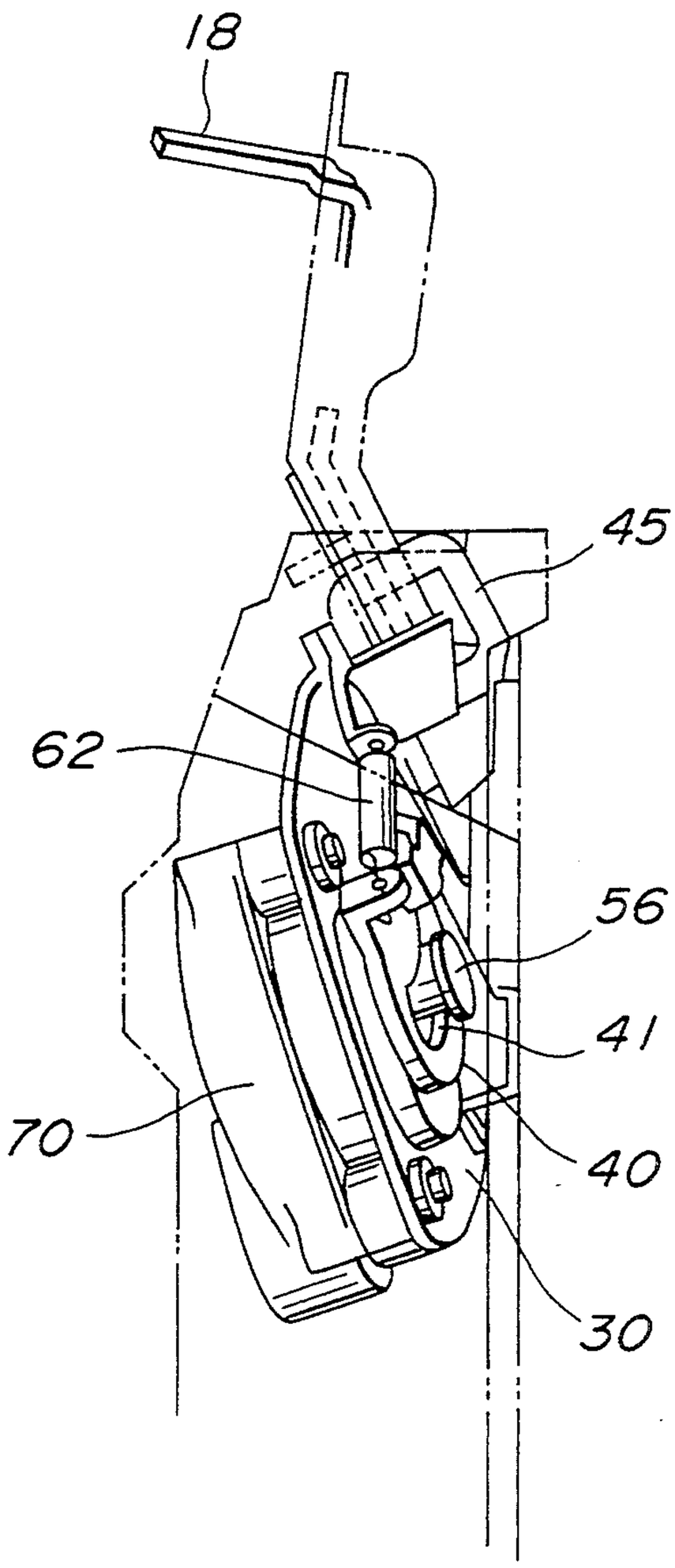
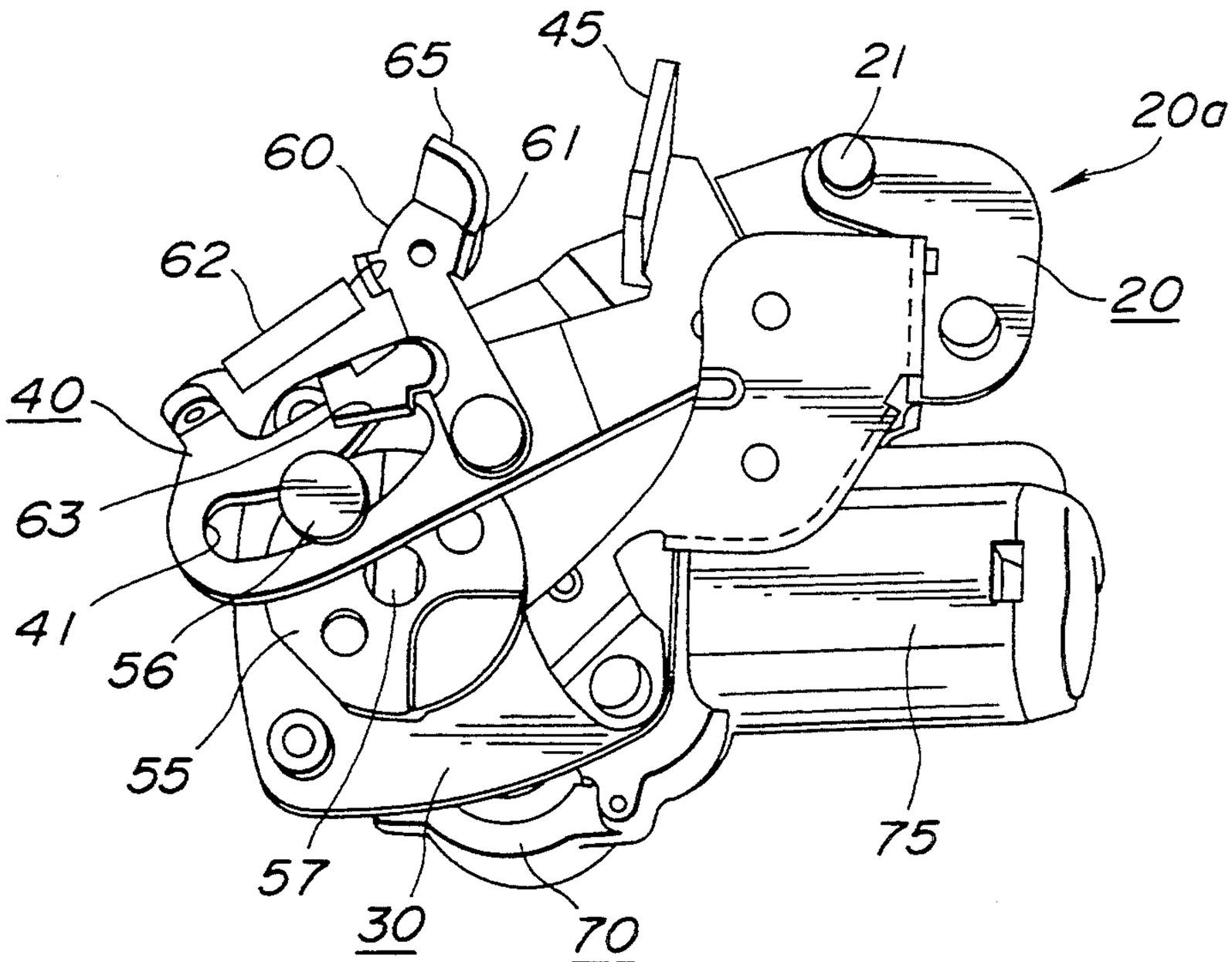


FIG.21


45
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20a
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70
75

FIG.22

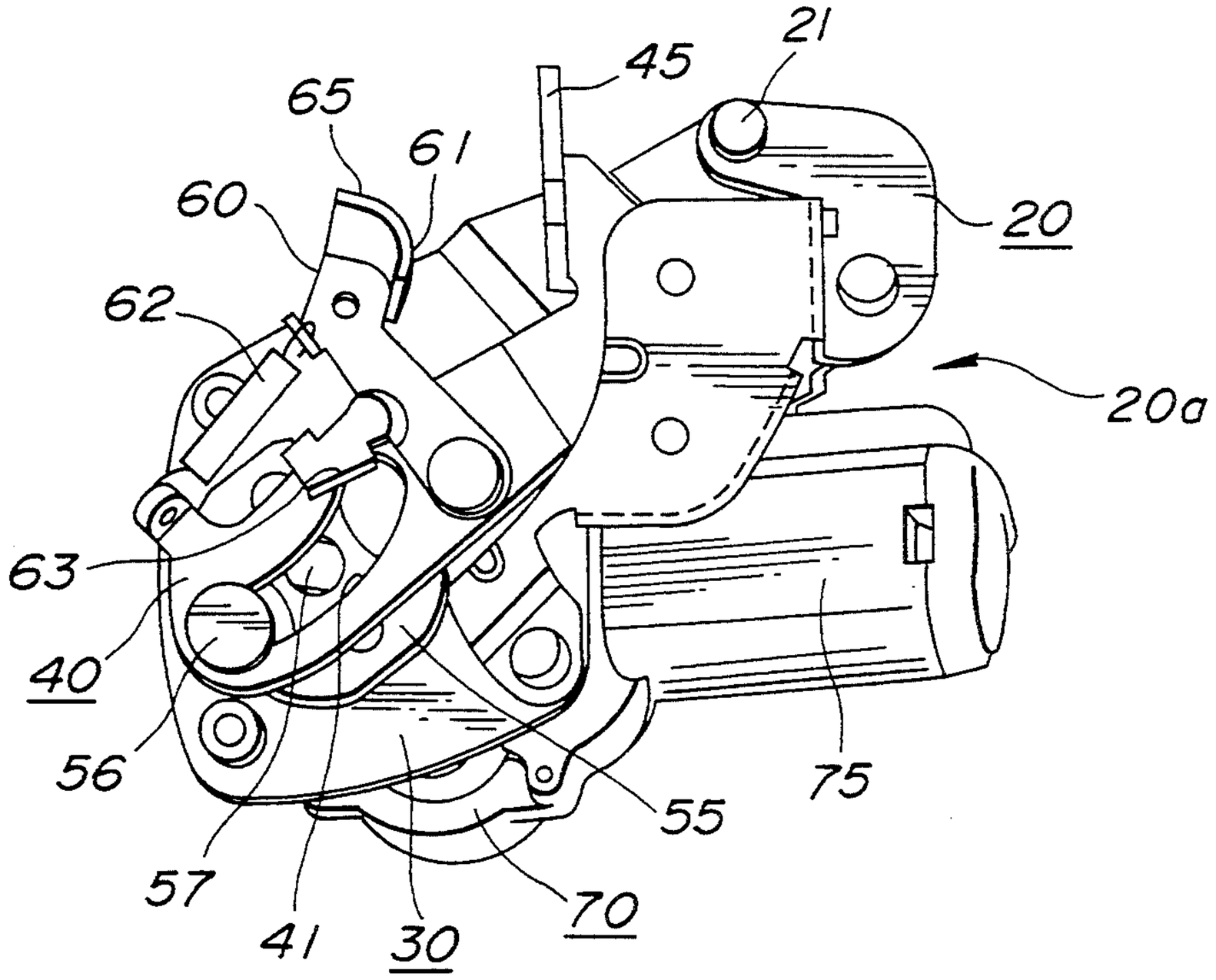
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FIG.23

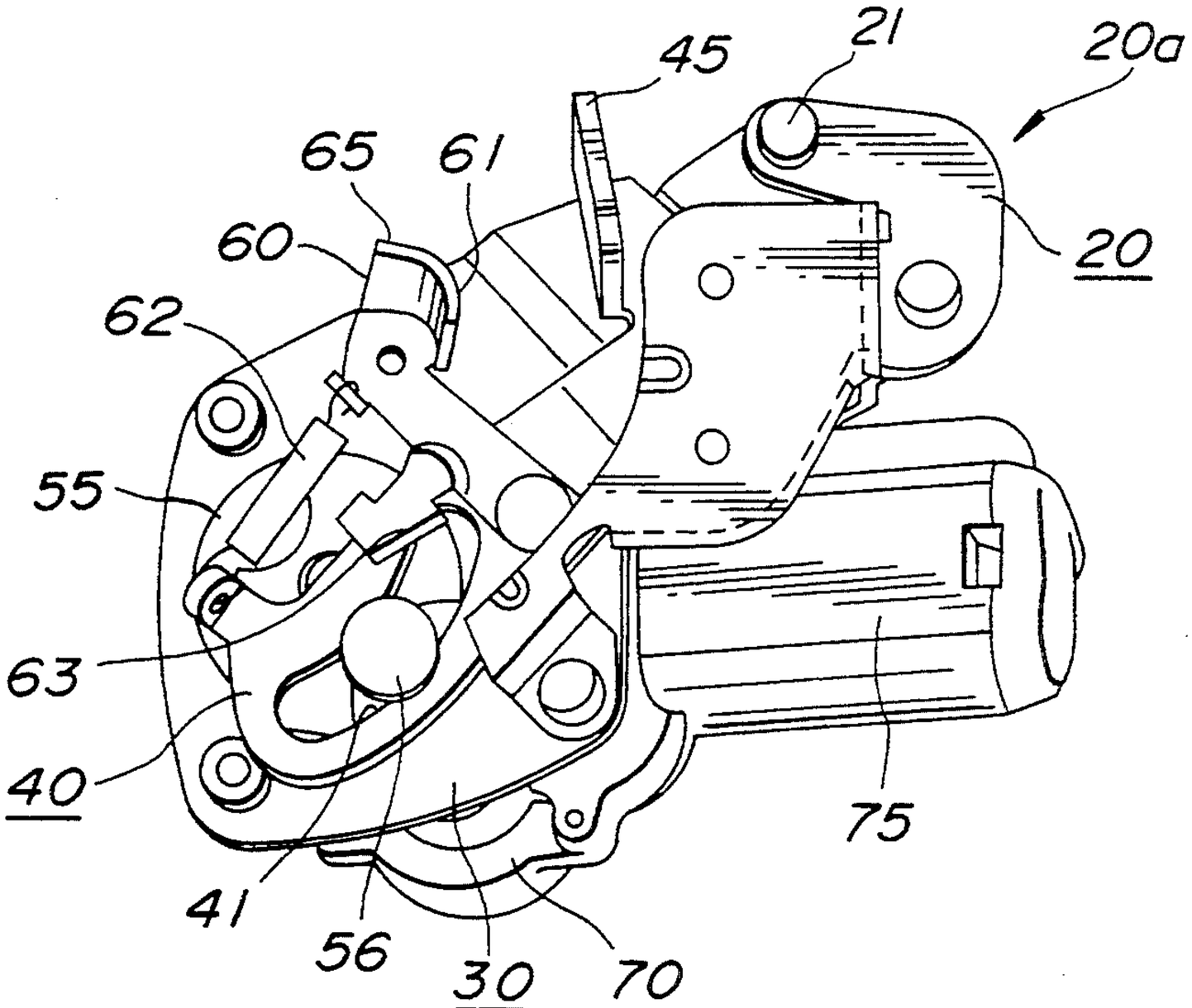
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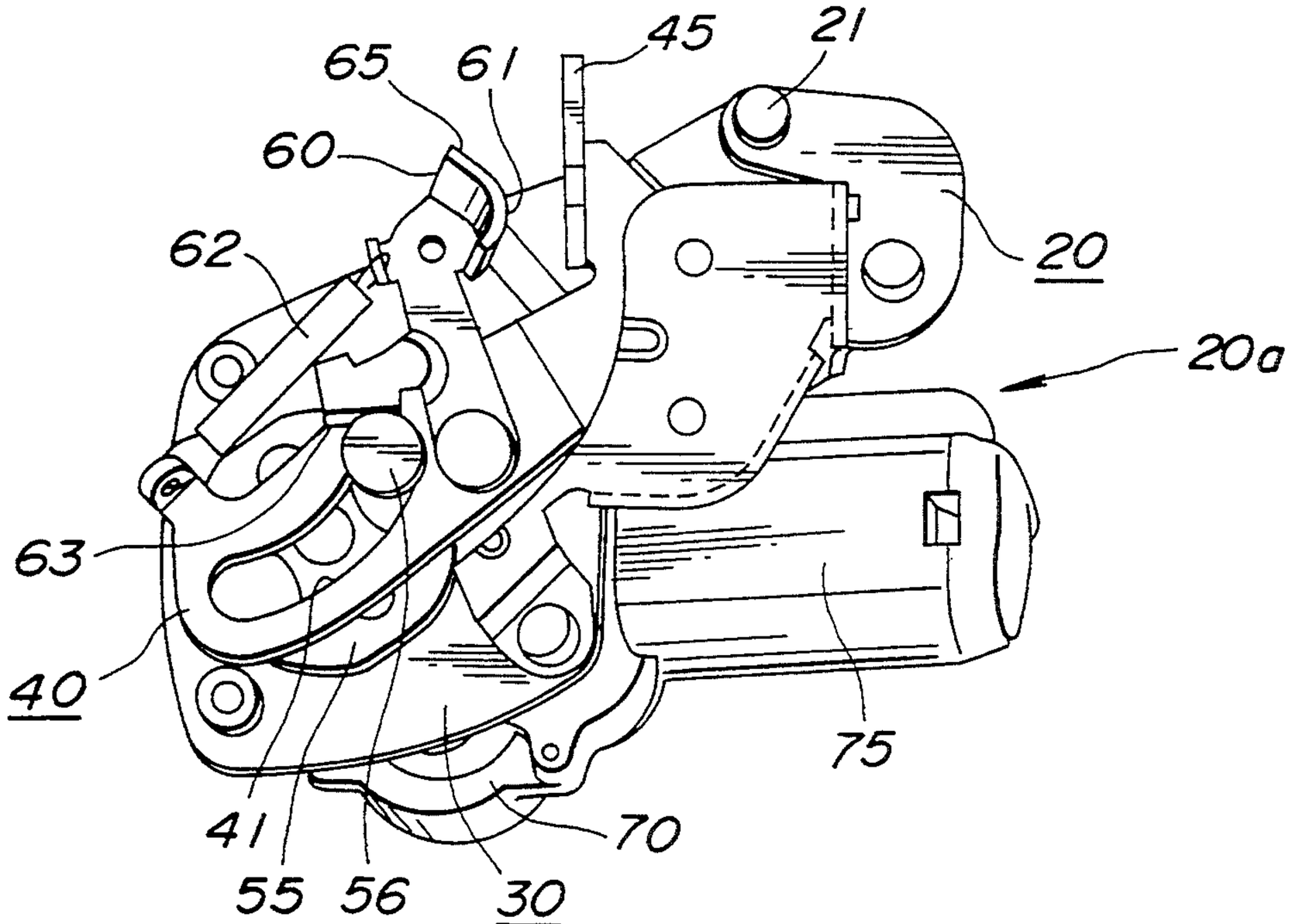
FIG.24


45
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61
60
20
62
20a
63
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75
41
70
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56
30

FIG.25

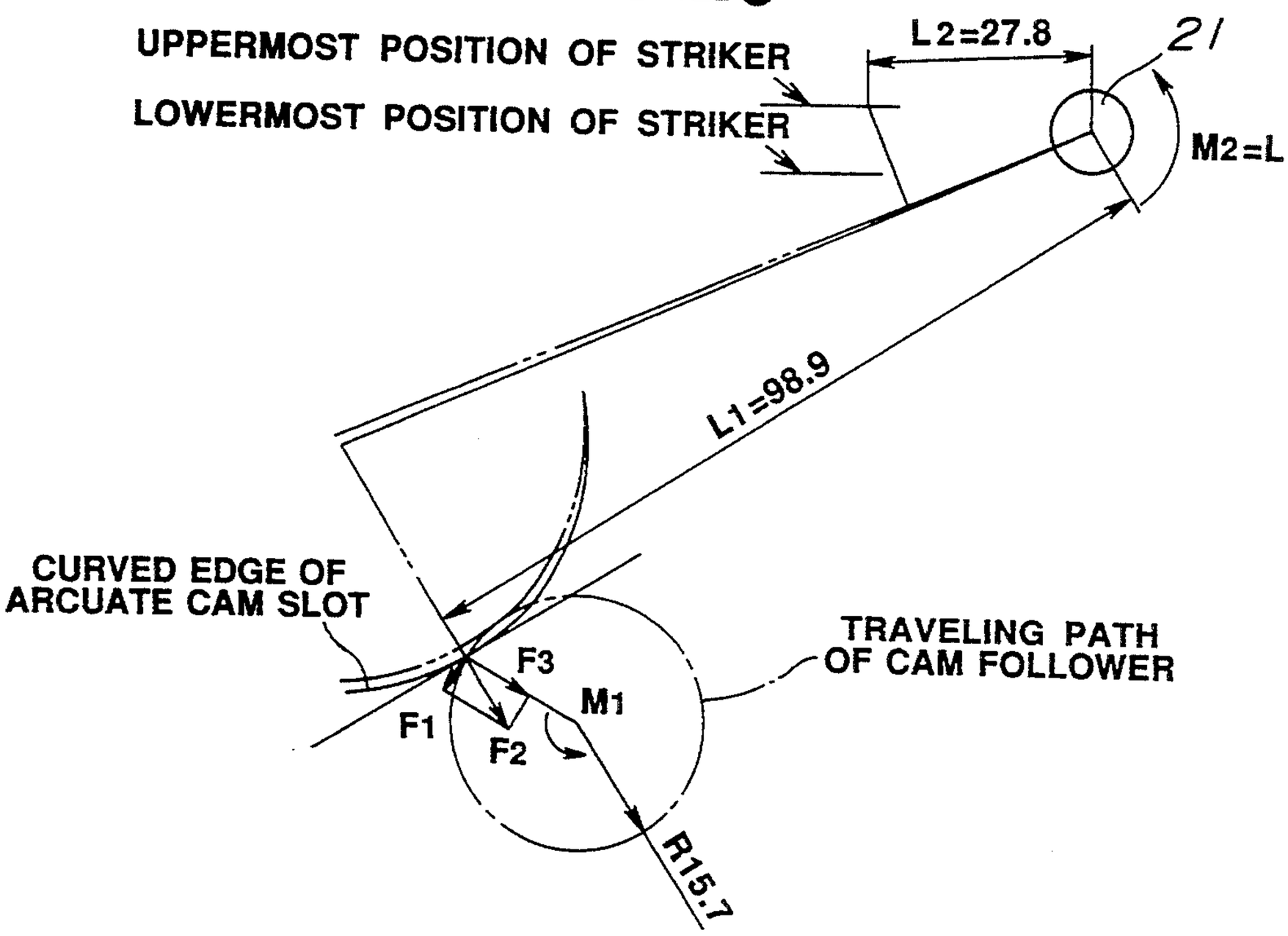

UPPERMOST POSITION OF STRIKER
LOWERMOST POSITION OF STRIKER
L2=27.8
21
M2=L
L1=98.9
CURVED EDGE OF ARCUATE CAM SLOT
TRAVELING PATH OF CAM FOLLOWER
F3
M1
F1
F2
R15.7

FIG.26

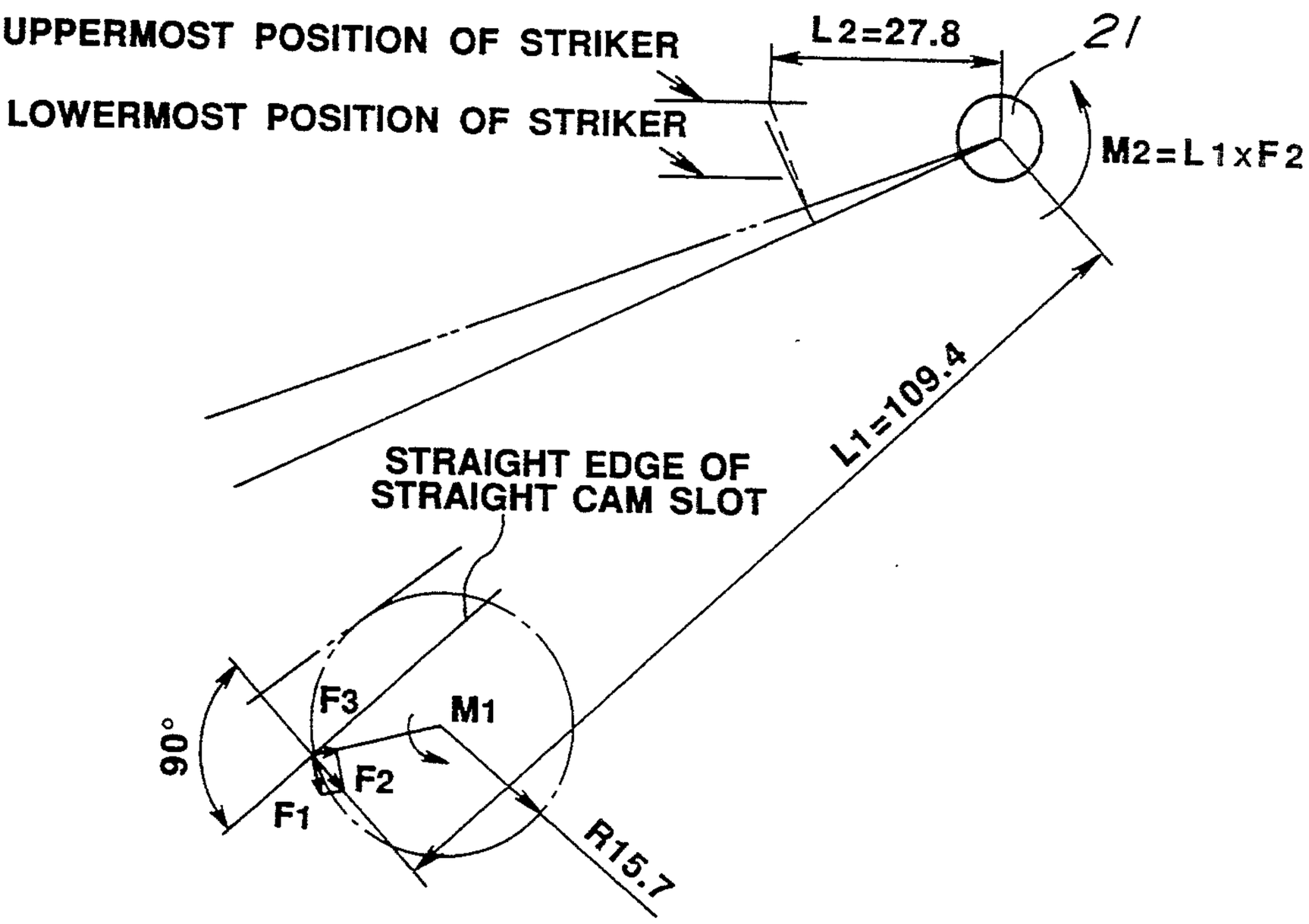
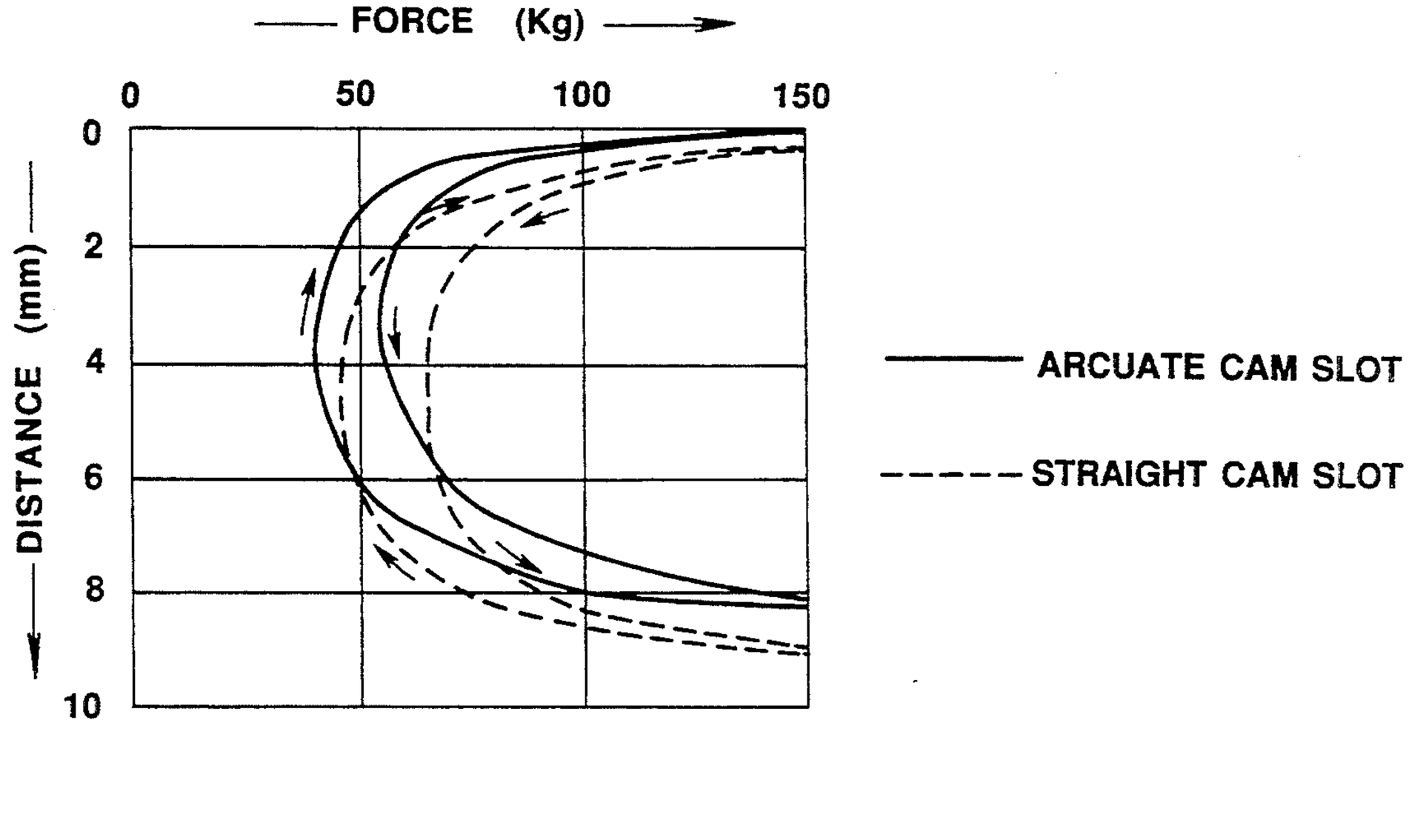

UPPERMOST POSITION OF STRIKER
LOWERMOST POSITION OF STRIKER
L2=27.8
21
M2=L1xF2
STRAIGHT EDGE OF STRAIGHT CAM SLOT
L1=109.4
90°
F3
M1
F2
F1
R15.7

FIG.27


FORCE (Kg)
0
50
100
150
DISTANCE (mm)
0
2
4
6
8
10
ARCUATE CAM SLOT
STRAIGHT CAM SLOT

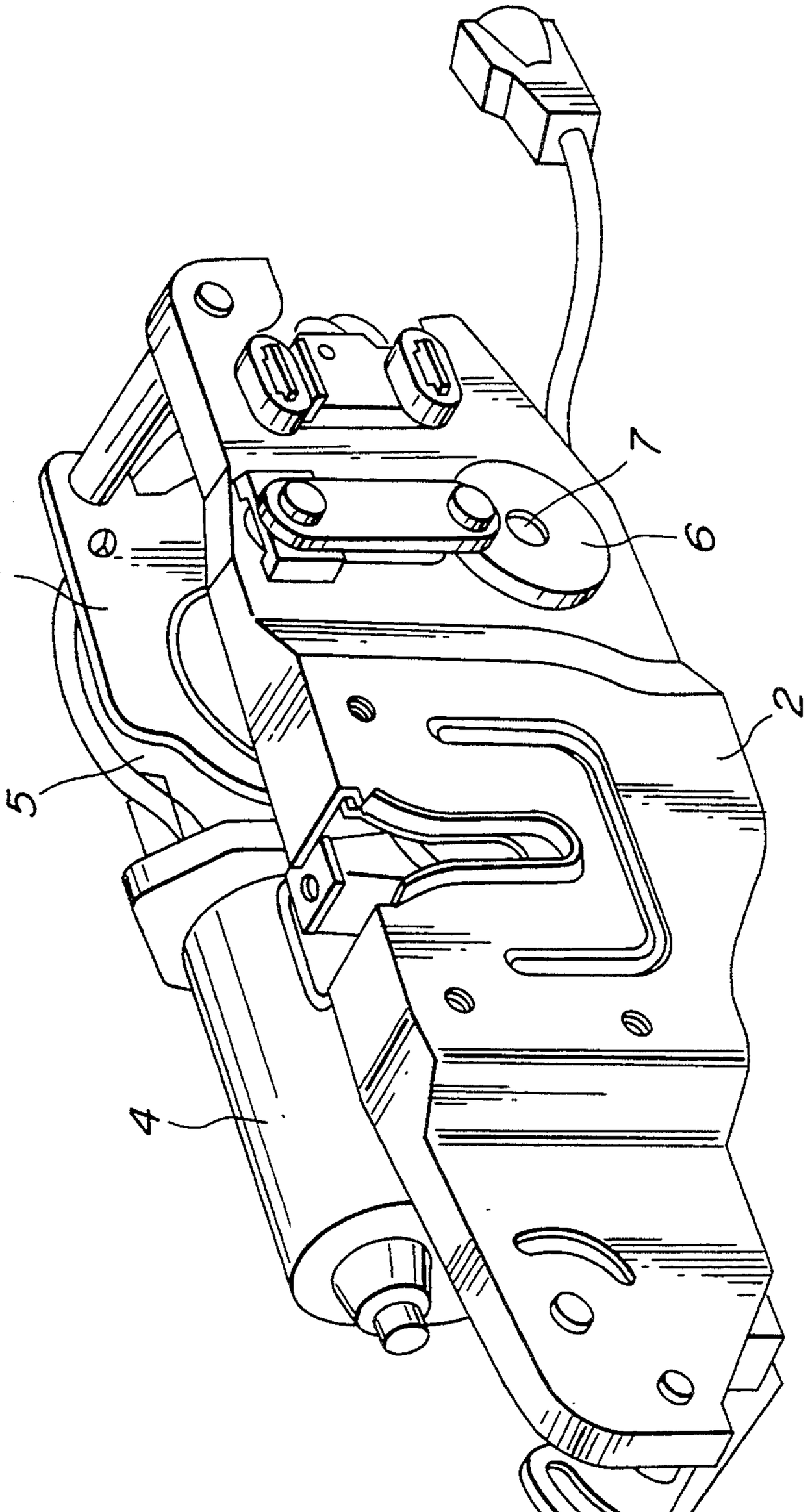


FIG.28
(PRIOR ART)

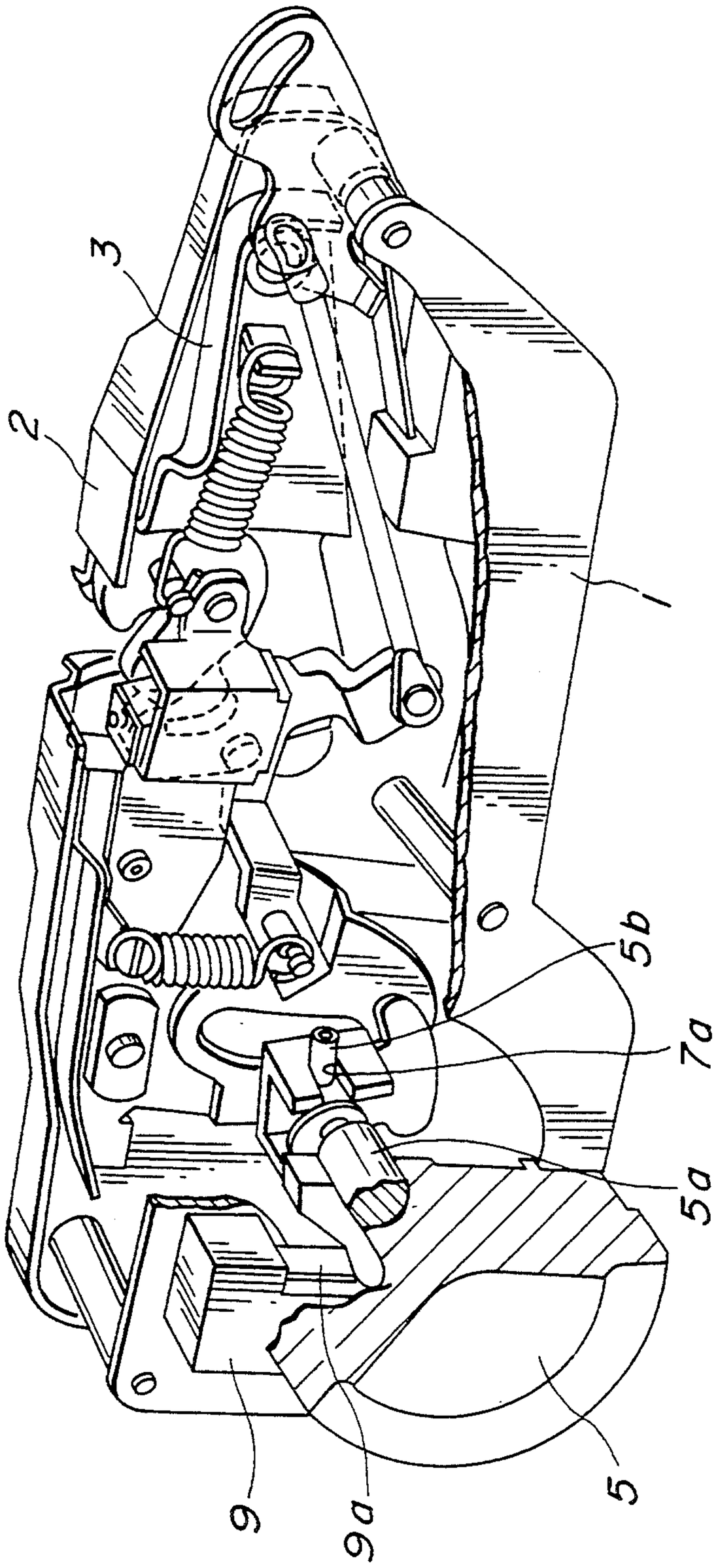


FIG.29
(PRIOR ART)

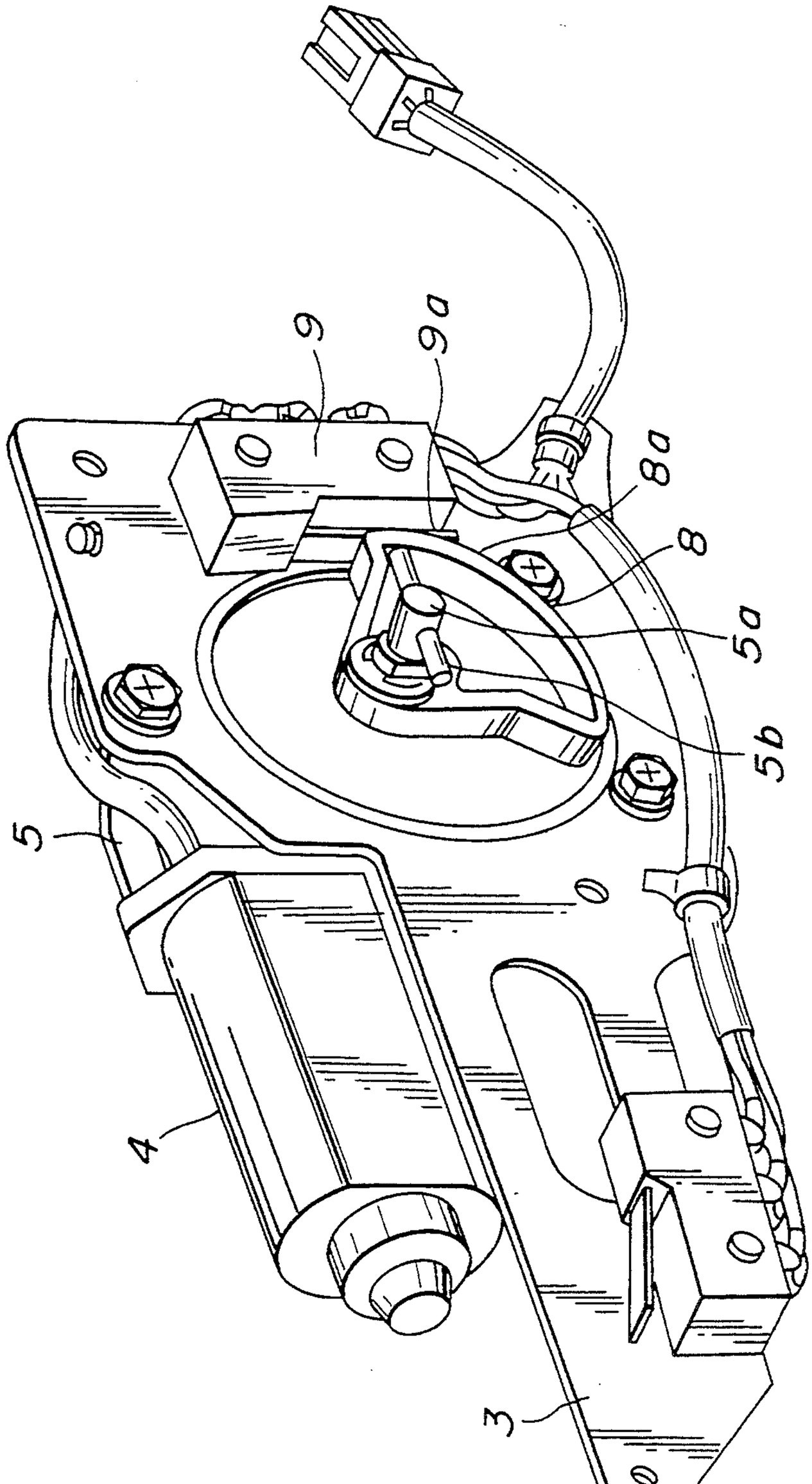


FIG.30
(PRIOR ART)

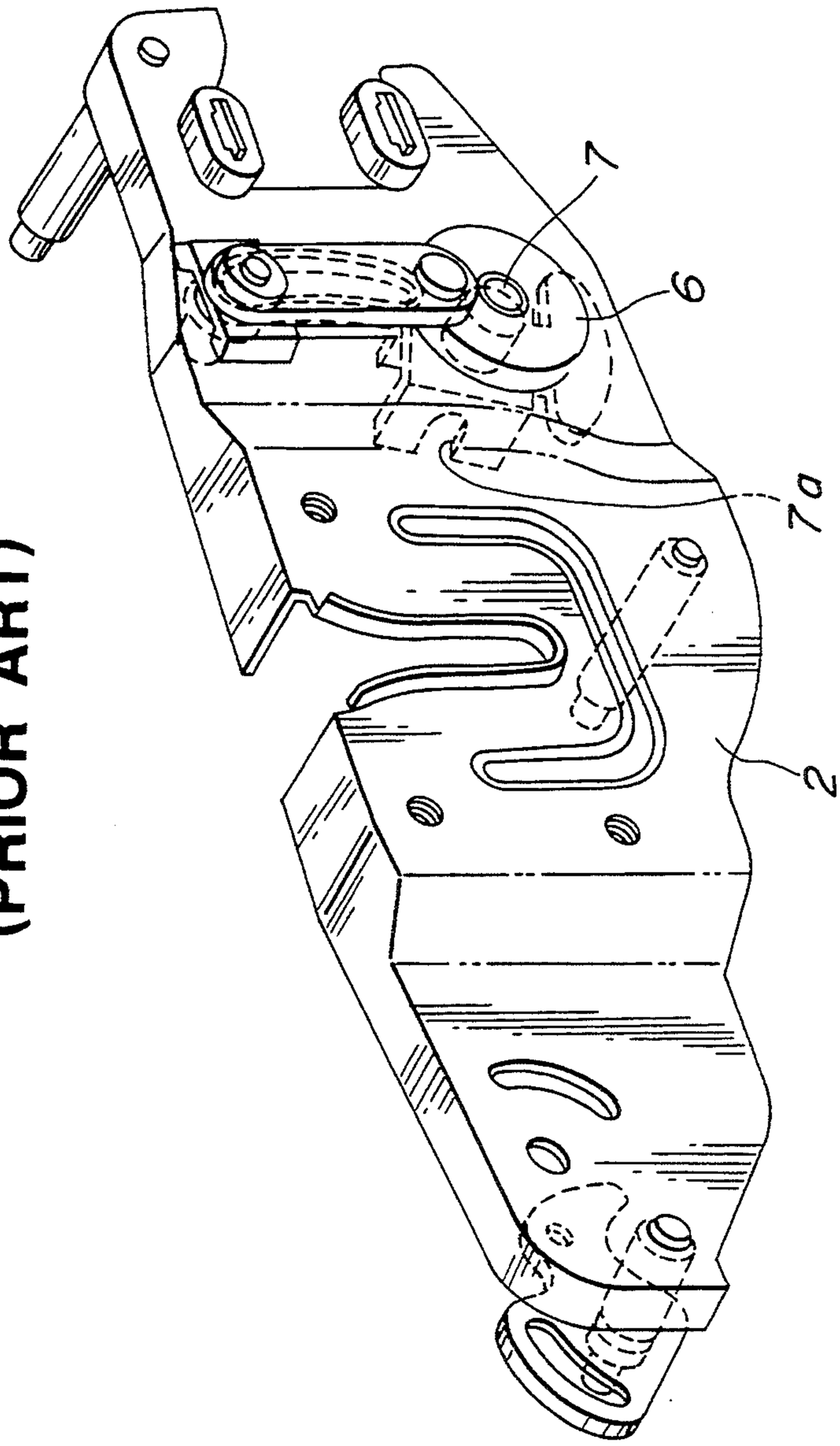


FIG.31
(PRIOR ART)

POWER LID CLOSING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to power lid closing devices for motor vehicles and more particularly to power lid closing devices for closing a lid, such as a trunk lid or the like, by the force of an electric power. More specifically, the present invention is concerned with power lid closing devices of a type which comprises a lid drawing mechanism mounted on a trunk structure of a vehicle body and an electric power unit coupled with the lid drawing mechanism for powering the same, wherein when a trunk lid is manually pivoted down to an almost closed position, the lid drawing mechanism catches the trunk lid and enforcedly pulls down the same to the fully closed position.

2. Description of the Prior Art

In order to clarify the task of the present invention, one conventional power lid closing device of the above-mentioned type will be described with reference to FIGS. **28** to **31**, which is shown in Japanese Patent First Provisional Publication 4-302683.

As is understood from FIGS. **28** and **29**, the conventional power lid closing device comprises a motor mounting plate **1** and a cover base plate **2** which face each other to define therebetween a space. As is seen from FIG. **29** a latch base plate **3** is installed in the space and has one end pivotally supported. The motor mounting plate **1** carries thereon an electric motor **4** (see FIG. **28**) and a speed reduction gear **5**. An output shaft **5**a of the speed reduction gear **5** is projected into the space between the motor mounting plate **1** and the cover base plate **2**. As is best seen from FIG. **30**, the output shaft **5***a* has at a leading end thereof a connecting pin **5***b* connected thereto. As will be seen from FIG. **31**, the cover base plate **2** is provided near the output shaft **5***a* of the speed reduction gear **5** with an output shaft **7** of a driving mechanism **6** by which the latch base plate **3** is pivoted. As is seen from FIG. **29**, a leading end of the output shaft **7** is formed with an engaging groove **7***a* with which the connecting pin **5***b* of the output shaft **5***a* is engaged. Thus, the output shaft **5***a* and the other output shaft **7** can rotate like a unit. Because of a so-called "joint mechanism" provided by both the connecting pin **5***b* and the engaging groove **7***a*, the connection of the output shaft **5***a* to the output shaft **7** is achieved with ease. That is, even though a slight displacement is present between these two output shafts **5***a* and **7** upon assembly, operative connection is achieved therebetween. As is seen from FIG. **30**, the output shaft **5***a* of the speed reduction gear **5** has a sector cam **8** secured thereto. A limit switch **9** is mounted to the motor mounting plate **1**, which has a detecting arm **9***a* slidably engaged with a cam surface **8** of the sector cam **8**. Thus, the angular position of the output shaft **5***a* of the speed reduction gear **5** can be detected by the limit switch **9**. In accordance with information signals issued by the limit switch **9**, operation of the electric motor **4** is controlled.

However, in the above-mentioned conventional power lid closing device, the joint mechanism provided by both the connecting pin **5***b* and the engaging groove **7***a* is excessively long, which causes a marked increase in thickness of the lid closing device and thus brings about a bulky construction of the same. Furthermore, in the conventional device, the joint mechanism tends to produce a noise due to its inherent construction. Furthermore, in the conventional device, the lid pulling force generated by the device is generally constant and relatively strong throughout the closing stroke for the lid. Thus, if operator's hand or hands are accidentally caught in the lid during closing movement of the lid, he or she can not pull out the hands with ease.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a power lid closing device which is free of the above-mentioned drawbacks.

According to the present invention, there is provided a power lid closing device for use in a structure wherein a lid member is pivotally connected to a fixed member. The lid closing device comprises a lock mechanism mounted on the lid member; and a lid drawing mechanism mounted on the fixed member, the lid drawing mechanism including a motor mounting plate which is stationary, a striker base plate which is pivotally connected to the motor mounting plate and an output disc which pivots the striker base plate when rotated, the striker base plate having a striker engageable with the lock mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

FIG. **1** is an exploded view of a power lid closing device of the present invention;

FIG. **2** is a rear view of a passenger motor vehicle to which the power lid closing device of the invention is practically applied;

FIG. **3** is an exploded view of an electric drive unit employed in the power lid closing device of the present invention;

FIG. **4** is a back view of the electric drive unit which is assembled;

FIG. **5** is a front view of the assembled electric drive unit;

FIG. **6** is a sectional view taken along the line VI—VI of FIG. **4**;

FIG. **7** is a front view of the assembled electric drive unit with a cover part removed for clarification of the drawing;

FIGS. **8** to **11** are front views of a rotary switch incorporated with the electric drive unit, but showing different operation conditions respectively;

FIG. **12** is an exploded view of a transmission mechanism employed in the electric drive unit;

FIGS. **13** to **17** are front views of the transmission mechanism which is assembled, but showing different operation conditions respectively;

FIG. **18** is a front view of essential parts of the power lid closing device;

FIG. **19** is a back view of the power lid closing device;

FIG. **20** is a side view of the power lid closing device;

FIGS. **21** to **24** are views of essential parts of the power lid closing device, but showing different operation conditions;

FIGS. **25** and **26** are schematic illustrations each showing the positional relationship between a cam groove and a cam follower;

FIG. 27 is a graph showing a lid pulling force produced by the power lid closing device;

FIG. 28 is a perspective front view of a conventional power lid closing device;

FIG. 29 is a partially broken perspective back view of the conventional power lid closing device;

FIG. 30 is a perspective front view of the conventional power lid closing device, with some parts removed for clarification of the drawing; and

FIG. 31 is a perspective view of a cover base plate with some parts associated therewith, which is one part of the conventional power lid closing device.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 to 27 of the drawings, there is shown a power lid closing device according to the present invention.

As is seen from FIG. 2, the power lid closing device of the present invention, which will be described in detail in the following, is applied to a rear trunk construction of a passenger motor vehicle.

The rear trunk construction comprises a trunk space **11** which is defined in a rear portion of the vehicle body and a trunk lid **10** which is pivotally connected to the vehicle body to close and open the trunk space **11**. Although not shown in the drawing, a conventional weather strip extends along the periphery **12** of the mouth of the trunk space **11**.

As shown in FIG. 2, the trunk lid **10** has at its leading edge portion a lock mechanism **15** mounted thereto, and the vehicle body has a lid drawing mechanism **20***a* mounted thereto. As will become apparent as the description proceeds, when the trunk lid **10** is pivoted down to an almost closed position, the lock mechanism **15** catches a striker (**45**) of the lid drawing mechanism **20***a* and thereafter the lid drawing mechanism **20***a* draws down the trunk lid **10** into a fully closed position by electric power.

As is seen from FIG. **18**, the lock mechanism **15** comprises a lock base plate **16** secured to the trunk lid **10**. The lock base plate **16** is formed at its lower part with a generally triangular recess **16***a* into which the striker (**45**) of the lid drawing mechanism **20***a* is inserted upon closing of the trunk lid **10**. A latch plate **17** and a locking plate **18** are pivotally connected to the lock base plate **16**. A tension spring **19** extends between the latch plate **17** and the locking plate **18** to bias them in opposite directions. As will be described in detail hereinafter, the latch plate **17** can pivot to a latching position to latch the striker (**45**) of the lid drawing mechanism **20***a* and, the locking plate **18** can pivot between a locking position wherein the locking plate **18** is engaged with the latch plate **17** to lock the same at the latching position and an unlocking position wherein the locking plate **18** is disengaged from the latch plate **17** to permit the same to release the striker (**45**). The tension spring **19** biases the latch plate **17** and the locking plate **18** in the directions to achieve the engagement therebetween. The locking plate **18** has a lower end **18***a* which is rounded.

As is understood from FIG. **19**, a switch **100** is fixed to the lock base plate **16**. The switch **100** has a switch knob **102** which is actuated by the locking plate **18**. That is, when the switch knob **102** is pressed by the locking plate **18**, the switch **100** assumes OFF condition, while, when the knob **102** is released from the locking plate **18**, the switch **100** assumes ON condition.

As is seen from FIGS. **1** and **18**, the lid drawing mechanism **20***a* comprises a base plate member **20** secured to an inner panel of the trunk space **11**, a motor mounting plate **30** superposed over the base plate member **20** and a striker base plate **40** which is installed within a clearance defined between the base plate member **20** and the motor mounting plate **30**. The base plate member **20** and the motor mounting plate **30** constitute a supporting base structure.

As is seen from FIG. **1**, a pivot pin **21** extends between the base plate member **20** and the motor base plate **30**, by which one end of the striker base plate **40** is pivotally held. Thus, the striker base plate **40** can pivot about the pivot pin **21** between a drawing start position as shown in FIG. **21** wherein the free end of the plate **40** is raised and a drawing stop position as shown in FIG. **23** wherein the free end of the plate **40** is lowered. The striker base plate **40** is integrally formed with the above-mentioned striker **45**. As shown, the striker **45** comprises a bent part **46** of the plate **40**, which is formed with an engaging opening **47**.

As is best shown in FIG. **1**, a drive mechanism **50** is mounted to the other end portion of the base plate member **20**, which functions to draw or pull down the above-mentioned latch plate **17** of the lock mechanism **15** through the striker **45**. The drive mechanism **50** comprises an arcuate cam slot **41** which is formed in the free end portion of the striker base plate **40** and an output disc **55** which is rotatably connected to one end of the motor mounting plate **30**. The output disc **55** has at one end a cam follower **56** which is slidably engaged with the cam slot **40**.

As will be described hereinafter, when, due to the function of a power unit, the output disc **55** is rotated in one direction, the cam follower **56** slidably moves in the arcuate cam slot **41** pivoting the striker base plate **40** about the pivot pin **21** between the drawing start position (FIG. **21**) and the drawing stop position (FIG. **23**).

The arcuate cam slot **41** is so shaped that upon rotation of the output disc **55** at a constant speed causing the striker base plate **40** to pivot downward from the drawing start position toward the drawing stop position, the pivoting speed of the striker base plate **40** changes. That is, at an initial stage of the lid drawing movement, the pivoting speed of the striker base plate **40** is relatively high and thus the lid pulling force is relatively small, and at a final stage of the lid drawing movement, the pivoting speed of the striker base plate **40** is relatively low and thus the lid pulling force is relatively large. In order to achieve such movement, the arcuate cam slot **41** has a radius of curvature which is slightly larger than that described by the cam follower **56** on the output disc **55**.

As is seen from FIGS. **1** and **18**, an open lever **60** is pivotally connected at its lower end to the striker base plate **40**. The open lever **60** functions to abut against the lower rounded end **18***a* of the locking plate **18** of the locking mechanism **20***a* to pivot the locking plate **18** from the locking position to the unlocking position.

As is seen from FIG. **1**, the open lever **60** is formed at its upper end with an output portion **61** which is engageable with the lower end **18***a* of the locking plate **18**. A spring **62** extends between the striker base plate **40** and the open lever **60**, so that the open lever **60** is biased in a direction away from the lower end **18***a* of the locking plate **18**.

The open lever **60** is formed at its middle part with an input portion **63**. When the striker base plate **40** is re-

turned from the drawing stop position to the drawing start position, the input portion **63** functions to pivot the open lever **60** to the position to engage with the lower end **18***a* of the locking plate **18**. That is, under this condition, the cam follower **56** of the output disc **55** pushes the input portion **63** of the open lever **60**. As is seen from FIG. **18**, the input portion **63** extends toward an end of the arcuate cam slot **41**, so that when the cam follower **56** comes to the end of the slot **41**, the input portion **63** is pressed by the cam follower **56**.

Furthermore, the open lever **60** is formed at the output portion **61** with a smoothly curved pushing portion **65**. Upon a given condition, the pushing portion **65** pushes up the lower end **18***a* of the locking plate **18** thereby to slightly lift the trunk lid **10** from the fully closed position. With this, a small clearance is created between the periphery **12** of the trunk opening **11** and the trunk lid **10**, which is sized to receive operator's hands for facilitation of manipulation to fully open the trunk lid **10**. That is, in operation, the pushing portion **65** is brought into engagement with the lower end **18***a* of the locking plate **18** to pivot the same to the unlocking position, and thereafter, the pushing portion **65** pushes up the lower end **18***a* of the locking plate **18**. During this, the lower end **18***a* of the locking plate **18** is forced to slide on and along the smoothly curved pushing portion **65**.

As is seen from FIG. **1**, the center of the output disc **55** is formed with a rectangular opening with which one rectangular end of an input shaft **57** is engaged. The other end of the input shaft **57** is formed with a rectangular key **58** which is projected through the motor mounting plate **30** into a side where a power unit **70** is located The power unit **70** is mounted to a back surface of the motor mounting plate **30**.

As is seen from FIG. **3**, the power unit **70** has a housing **71** which consists of two connectable halves. Within the housing **71**, there are installed an electric motor **75** and a speed reduction gear **80**. As shown, the electric motor **75** has an output shaft (no numeral) which extends axially in the housing **71**. A worm **76** is fixed to the output shaft of the motor **75** to rotate therewith. The worm **76** is connected through two idle gears **81** and **82** to a spur gear **83**.

As is seen from FIGS. **3** and **7** to **11**, the spur gear **83** is formed at its back side with a circular cam groove **84** which is eccentric with respect to the rotation center of the spur gear **83**. Within the housing **71**, there is further installed a rotary switch **78** which has a pivotal switch lever **79** incorporated with the eccentric cam groove **84** of the spur gear **83**. That is, the switch lever **79** has at its leading end a projection (no numeral) which is slidably engaged with the cam groove **84**. Because of the eccentricity of the groove **84**, rotation of the spur gear **83** induces ON-OFF operation of the rotary switch **78**.

As is seen from FIG. **1**, upon assembly of the power lid closing device of the invention, the spur gear **83** is so arranged that the axis thereof is perpendicular to the motor mounting plate of the lid drawing mechanism **20***a*.

As is seen from FIGS. **6** and **12** to **17**, the spur gear **83** is formed at its front side with a circular recess **85** into which a transmission disc **90** is received. The diameter of the circular recess **85** is somewhat larger than that of the transmission disc **90**, so that the disc **90** can play in the recess **85**. The transmission disc **90** is formed at a peripheral portion with a bent arm **91**. The bent arm **91** is equipped with a slider or damper member **92** for achieving a smoothed movement of the bent arm **91** relative to the radially extending groove **86**. Upon assembly, the slider or damper member **92** is slidably received in a radially extending groove **86** formed in the front side of the spur gear **83**. The radially extending groove **86** and the circular recess **85** are merged with each other. Of course, the radially extending groove **86** is deeper in depth than the circular recess **85**. With such connection between the spur gear **83** and the transmission disc **90**, the transmission disc **90** can move in a radial direction but slightly in the circular recess **85** of the spur gear **83**. Furthermore, due to the dimensional difference between the circular recess **85** and the transmission disc **90**, the latter can play slightly in the recess **85**. That is, the power transmission from the spur gear **83** to the transmission disc **90** is smoothly made while permitting a radial play of the disc **90** in the circular recess **85**.

As is best shown in FIG. **12**, the transmission disc **90** is formed at its center with a collared key opening **94**. The collar is designated by numeral **93**. As is seen from FIG. **1**, the collared key opening **94** tightly receives therein the other end **58** (viz., rectangular key) of the input shaft **57**. Thus, the output disc **55**, the input shaft **57** and the transmission disc **90** rotate together.

In the following, operation of the power lid closing device will be described with reference to the drawings.

For ease of understanding, the description will be commenced with respect to a condition wherein the trunk lid **10** is fully opened as shown in FIG. **2**. Under this condition, the lock mechanism **15** mounted on the trunk lid **10** assumes its open position, and the lid drawing mechanism **20***a* shows such a condition as shown in FIG. **21**. That is, (see FIG. **18**), in the lock mechanism **15**, a projection **17***a* of the latch plate **17** engages with a recessed part **18***b* of the locking plate **18** thereby causing the locking plate **18** to press the switch knob **102** of the switch **100** (see FIG. **19**), and in the lid drawing mechanism **20***a*, the striker base plate **40** is raised assuming the drawing start position, and the switch lever **79** of the rotary switch **78** assume such an angular position as shown in FIG. **9** causing OFF condition of the switch **78**. Furthermore, as is shown in FIG. **21**, the cam follower **56** of the output disc **55** takes a generally middle position of the arcuate cam slot **41**.

When the trunk lid **10** is pivoted down to an almost closed position, the latch plate **17** of the lock mechanism **15** catches the striker **45** of the striker base plate **40** of the lid drawing mechanism **20***a* and thus assumes the latching position, and instantly the locking plate **18** becomes engaged with the latch plate **17** to lock the same at the latching position. Due to this movement, the locking plate **18** is separated from the switch knob **102** of the switch **100** inducing ON condition of the same. Upon this, the electric motor **75** of the power unit **70** is energized, so that as is seen from FIG. **7**, the spur gear **83** is rotated in a given direction through the worm **76** and the idle gears **81** and **82**, and thus the transmission disc **90** (see FIG. **3**) is rotated in the same direction. Due to the rotation of the transmission disc **90**, the output disc **55** is rotated to actuate the drive mechanism **50** of the lid drawing mechanism **20***a*.

That is, in response to the counterclockwise rotation of the output disc **55**, the cam follower **56** (see FIG. **21**) carried by the output disc **55** is moved downward in the arcuate cam slot **41** from the middle position toward a left end of the slot **41** as is seen from FIG. **22**.

Because of the arcuate shape of the cam slot **41**, this movement of the cam follower **56** in the slot **41** induces a relatively large pivoting movement of the striker base plate **40** in a downward direction. Thus, at a first stage of the pivoting movement from the drawing start position, the trunk lid **10** is pivoted down at a relatively high speed. If the cam slot **41** is straight in shape, such high speed pivoting is not achieved.

It is to be noted that favorably such high speed pivoting of the trunk lid **10** to a certain angular position at the first stage brings about a relatively low pulling force generated by the drive mechanism **50**. This phenomenon will be easily understood from the graph of FIG. **27** which shows the relationship between the distance (D) from the lid drawing start position and the pulling (or pushing) force (F) generated by the drive mechanism **50**. Shown by a solid line curve is the relationship obtained by the arcuate cam slot **41**, while, shown by a broken line curve is that obtained by a straight cam slot. As is seen from the graph, the pulling force generated by the drive mechanism **50** at the first stage of the pivoting movement of the trunk lid **10** is very small as compared with that of the straight cam slot. Accordingly, in the present invention, even if operator's hands are accidentally caught between the trunk lid **10** and the periphery of the trunk space **11**, he or she can easily pull out the hands.

When, due to the continuous rotation of the output disc **55**, the cam follower **56** is moved upward from the left end of the cam slot **41** of FIG. **22** to the middle position as shown in FIG. **23**, the striker base plate **40** is pivoted down to the drawing stop position pulling down the trunk lid **10** against the counterforce produced by the weather strip on the periphery of the trunk space **11**. During this movement, the switch lever **79** (see FIG. **10**) of the rotary switch **78** is forced to slide in the eccentric cam groove **84** of the spur gear **83**. (More specifically, the spur gear **83** is rotated keeping the slidable engagement with the switch lever **79**). When the trunk lid **10** is fully closed causing the switch lever **79** to take such an angular position as shown in FIG. **11**, the rotary switch **78** is turned OFF and thus the electric motor **75** of the power unit **70** is deenergized.

As will be seen from the graph of FIG. **27**, when the trunk lid **10** is in the process of being pressed against the weather strip of the trunk space **11**, the pulling force generated by the drive mechanism **50** is large as compared with that of the straight cam slot. This means that the trunk lid **10** can be fully closed with assured sealing. When the trunk lid **10** is fully closed, the drawing mechanism **20***a* assumes the condition as shown in FIG. **23**.

FIGS. **25** and **26** are schematic illustrations showing respectively the paths traveled by the cam follower **56** of the output disc **55** when the cam slot **41** is arcuate and straight. In these drawings, the vector "F2" corresponds to the force with which the trunk lid **10** is pulled.

As is seen from FIGS. **21** and **22**, when the striker base plate **40** is being pivoted down from the drawing start position of FIG. **21** to the drawing stop position of FIG. **23**, the open lever **60** is kept free, that is, kept apart from the lower end **18***a* (see FIG. **18**) of the locking plate **18** and the cam follower **56** is kept separated from the input portion **63** of the open lever **60**.

In order to open the trunk lid **10**, the following operation is carried out.

As has been described hereinabove, when the trunk lid **10** is fully closed, the drawing mechanism **20***a* assumes the condition of FIG. **23**.

When an open switch (not shown) mounted in a passenger room of the vehicle is turned ON, the electric motor **75** of the power unit **70** is energized. With this, the output disc **55** is turned in the same direction, that is, in the counterclockwise direction, and thus, the cam follower **56** is moved upward in the arcuate cam slot **41** to a right end of the slot **41** as shown in FIG. **24**. During this, the cam follower **56** pushes the input portion **63** of the open lever **60** causing the open lever **60** (more specifically, the output portion **61**) to push the lower end **18***a* of the locking plate **18** (see FIG. **18**). Thus, the locking plate **18** is pivoted to the unlocking position to unlock the latch plate **17**. Thus, the lock mechanism **15** on the trunk lid **10** releases the striker **45** of the lid drawing mechanism **20***a*.

When thereafter, due to further rotation of the output disc **55**, the pushing portion **65** of the open lever **60** pushes up the lower end **18***a* of the locking plate **18**, the trunk lid **10** is slightly lifted. That is, the trunk lid **10** is forced to pivot up to a slightly open position even when a certain external load is applied to the trunk lid **10** due to presence of snow thereon and/or freezing of the trunk lid **10** to the vehicle body. Thereafter, the trunk lid **10** can be opened manually to its full open position by the operator.

During this, the switch lever **79** (see FIG. **8**) of the rotary switch **78** is forced to slide in the eccentric cam groove **84** of the spur gear **83**. When the switch lever **79** assumes the position as shown in FIG. **9**, the rotary switch **78** is turned OFF and the electric motor **75** of the power unit **70** becomes deenergized and the striker base plate **40** of the lid drawing mechanism **20***a* is returned to the drawing start position as shown in FIG. **21**.

In the following, advantages of the present invention will be described.

First, because the power unit **70** is compact in size, the entire construction of the power lid closing device can be constructed compactly. That is, unlike the case of the conventional device of Japanese Patent First Provisional Publication 4-302683, there is no need of using a so-called "elongate joint mechanism" in the present invention, and thus, the thickness of the device can be reduced. The arrangement wherein the axis of the spur gear **83** is perpendicular to the motor mounting plate **30** is important in reducing the thickness of the entire construction of the power lid closing device. Furthermore, usage of the spur gear **83** with which both the switch lever **79** of the rotary switch **78** and the transmission disc **90** are incorporated participates in reducing the size of the power lid closing device of the invention.

Second, since the transmission disc **90** is neatly received in the circular recess **85** of the spur gear **83**, the thickness of the overall thickness of the unit consisting of the spur gear **83** and the disc **90** is reduced, which also participates in reducing the size of the lid closing device.

Third, since the transmission disc **90** is radially movably received in the circular recess **85** of the spur gear **83**, combining the power unit **70** with the lid drawing mechanism **20***a* is easily achieved without paying marked attention to positioning therebetween. That is, even if there is a dislocation between the power unit **70** and the lid drawing mechanism **20***a*, the power transmission from the power unit **70** to the drawing mechanism **20***a* is assuredly made by the radially movable transmission disc **90**.

Fourth, because of the nature of the arcuate cam slot **41**, the downward movement of the trunk lid **10** at the first stage by the lid drawing mechanism **20***a* is carried out with a smaller pulling force. Thus, even if operator's hand or hands are accidentally caught in the downwardly moving trunk lid **10**, he or she can easily pull out the hands.

Fifth, because of the nature of the arcuate cam slot **41**, the downward movement of the trunk lid **10** at the final stage by the lid drawing mechanism **20***a* is carried out with a larger pulling force. This induces an assured compression of the weather strip of the trunk space **11** by the trunk lid **10**.

Sixth, since the open lever **60** functions to push up the locking plate **18** after canceling the locked condition of the latch plate **17**, the trunk lid **10** is assuredly lifted to a slightly open position even when a certain external load is applied to the trunk lid **10** due to presence of snow thereon and/or freezing of the trunk lid to the vehicle body.

What is claimed is:

1. A power lid closing device for use in a structure wherein a lid member is pivotally connected to a fixed member, comprising:

a lock mechanism mounted on said lid member;

a lid drawing mechanism mounted on said fixed member, said lid drawing mechanism including a motor mounting plate which is stationary, a striker base plate which is pivotally connected to said motor mounting plate and an output disc which pivots said striker base plate when rotated, said striker base plate having a striker engageable with said lock mechanism;

a power unit mounted to said motor mounting plate, said power unit including an electric motor and a speed reduction gear which are installed in a housing secured to said motor mounting plate, said speed reduction gear including a spur gear the axis of which is substantially perpendicular to said motor mounting plate;

means defining an eccentric cam groove in one side of said spur gear; and

a rotary switch having a pivotal switch lever, said switch lever having a projection slidably engaged with said eccentric cam groove, said rotary switch being electrically connected to said electric motor.

2. A power lid closing device as claimed in claim **1**, further comprising:

rotation transmitting means for transmitting rotation of said spur gear to said output disc irrespective of a certain axial displacement therebetween.

3. A power lid closing device as claimed in claim **2**, in which said rotation transmitting means comprises:

means defining a circular recess in another side of said spur gear;

means defining a radially extending groove in said another side of said spur gear;

a transmission disc radially movably received in said circular recess, said transmission disc having at its periphery a bent arm slidably engaged with said radially extending groove; and

a shaft member connecting respective centers of said transmission disc and said output disc.

4. A power lid closing device as claimed in claim **3**, in which said circular recess of said spur gear and said radially extending groove of said spur gear are merged with each other.

5. A power lid closing device as claimed in claim **3**, in which the depth of said radially extending groove is deeper than said circular recess.

6. A power lid closing device as claimed in claim **3**, in which said bent arm of said transmission disc is equipped with a slider member for achieving a smoothed movement of said bent arm relative to said radially extending groove.

7. A power lid closing device as claimed in claim **3**, in which said shaft member passes through an opening formed in said motor mounting plate, and said shaft member has two rectangular ends unmovably received in respective rectangular openings formed in said centers of said transmission disc and said output disc.

8. A power lid closing device as claimed in claim **7**, in which the rectangular opening of said transmission disc is collared.

9. A power lid closing device as claimed in claim **1**, in which said speed reduction gear further comprises:

a worm mounted on an output shaft of said electric motor; and

two mutually engaged idle gears which are meshed with said worm and said spur gear respectively.

10. A power lid closing device as claimed in claim **1**, in which said lid drawing mechanism further comprises:

means defining an arcuate cam slot in said striker base plate; and

a cam follower carried by said output disc, said cam follower being slidably engaged with said arcuate cam slot so that rotation of said output disc induces a traveling of said cam follower in said arcuate cam slot causing pivotal movement of said striker base plate.

11. A power lid closing device as claimed in claim **10**, in which said arcuate cam slot, due to rotation of said output disc, pivots said striker base plate down from a generally middle position to a lowermost position, wherein a pulling force generated by said striker base plate is gradually increased.

12. A power lid closing device as claimed in claim **11**, in which said arcuate cam slot is so shaped that the longitudinal ends thereof are directed upward with respect to said fixed member to which said lid member is pivotally connected.

13. A power lid closing device as claimed in claim **10**, in which said lid drawing mechanism further comprises an open lever which is pivotally connected to said striker base plate, said open lever canceling a locked condition of said lock mechanism when moved by said cam follower.

14. A power lid closing device as claimed in claim **13**, in which said open lever comprises:

a major portion pivotally connected to said striker base plate;

an input portion against which said cam follower abuts when said cam follower comes to one extreme end of said arcuate cam slot; and

an output portion which abuts against a lock member of said lock mechanism to cancel the locked condition of said lock mechanism when said major portion is pivoted in a predetermined direction by the abutment of said cam follower against said input portion.

15. A power lid closing device as claimed in claim **14**, in which said output portion of said open lever is formed with a pushing portion, said pushing portion pushing up a lower end of said lock member of said lock mechanism to lift up said lid member from said fixed

member when said major portion is pivoted in the predetermined direction by said cam follower.

16. A power lid closing device as claimed claim **15**, in which said pushing portion is smoothly curved.

17. A power lid closing device as claimed in claim **13**, in which said lock mechanism on said lid member comprises:

a lock base plate fixed to said lid member;

a latch plate pivotally connected to said lock base plate, said latch plate being capable of latching said striker of said striker base plate when they abut against each other; and

a locking plate which is said lock member, said locking plate being pivotally connected to said lid lock base plate, said locking plate being engageable with said latch plate to lock said latch plate at the latching condition.

18. A power lid closing device as claimed in claim **16**, further comprising a spring by which said latch plate and said locking plate are biased in opposite directions.

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